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Betsugi

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(54) **SURGICAL INSTRUMENT, ASSEMBLY INCLUDING ADAPTOR AND SURGICAL INSTRUMENT, AND ROBOTIC SURGICAL SYSTEM**

(71) Applicant: **MEDICAROID CORPORATION**, Kobe (JP)

(72) Inventor: **Shota Betsugi**, Kobe (JP)

(73) Assignee: **MEDICAROID CORPORATION**, Kobe (JP)

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CPC A61B 34/37; A61B 34/71; A61B 90/50; A61B 2034/301; A61B 2034/305;

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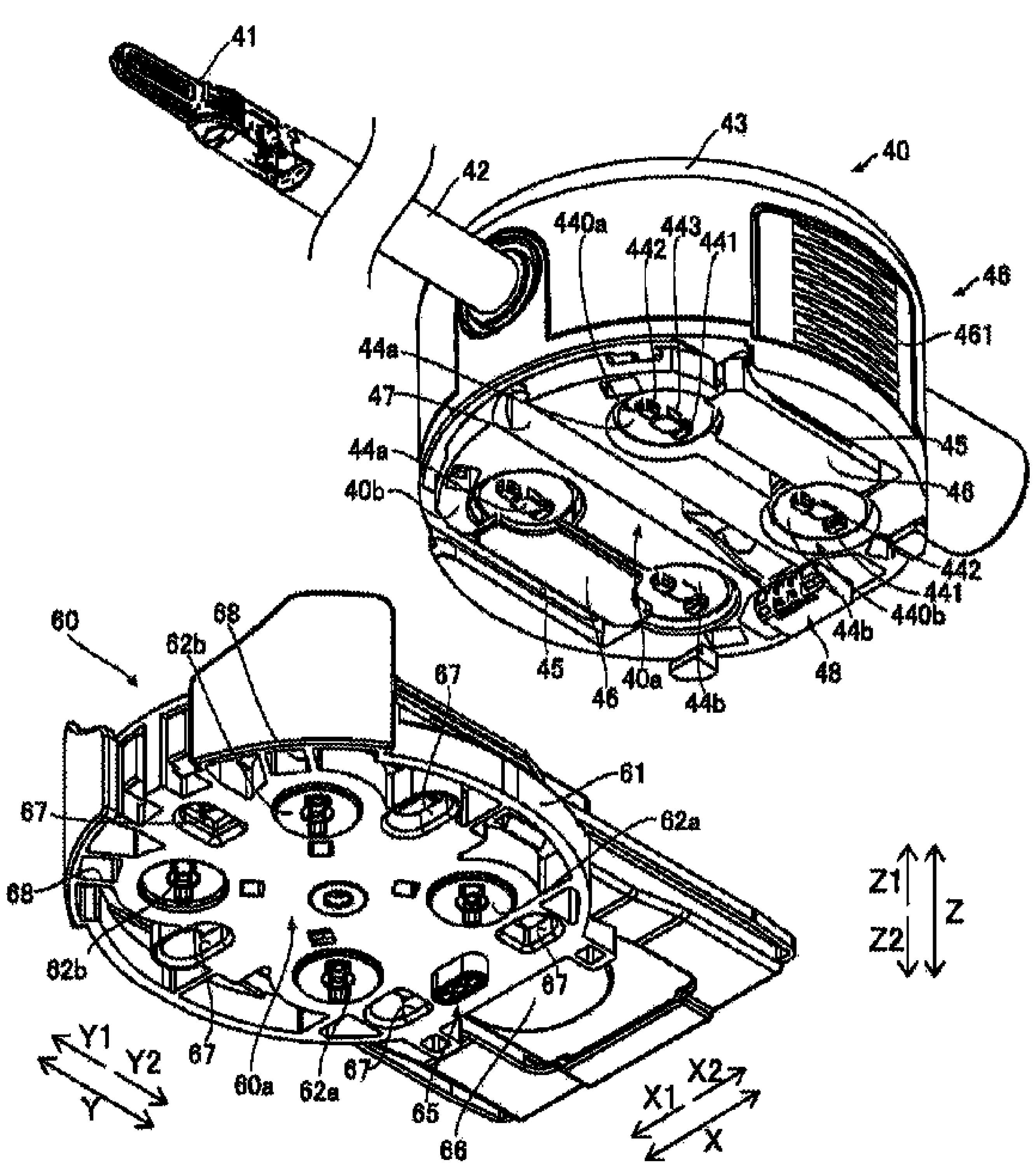
Primary Examiner — Tan-Uyen T Ho
Assistant Examiner — Regina Vahey
(74) *Attorney, Agent, or Firm* — Metrolex IP Law Group, PLLC

(57) **ABSTRACT**

A surgical instrument according to an embodiment may include: a base body including an attachment surface to be attached to the adaptor; an elongated shaft including one end connected to the base body; a treatment tool provided on a side of the other end of the shaft, elongate elements for operating the surgical tool, driven members rotatably provided on the base body and connected with end portions of the elongate elements; a holding member provided such that one end of each driven member is rotatably held by the base body and the other end of each driven member is rotatably held by the holding member; and a movable member provided movable with respect to the holding member and the base body and engageable with an adaptor. The movable member is configured, when moved with respect to the holding member and the base body, to be disengaged from the adaptor.

20 Claims, 12 Drawing Sheets



(51) **Int. Cl.**
A61B 34/00 (2016.01)
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(58) **Field of Classification Search**
CPC A61B 2017/00477; A61B 34/30; A61B 2017/0046; A61B 2017/00464
See application file for complete search history.

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FIG. 1

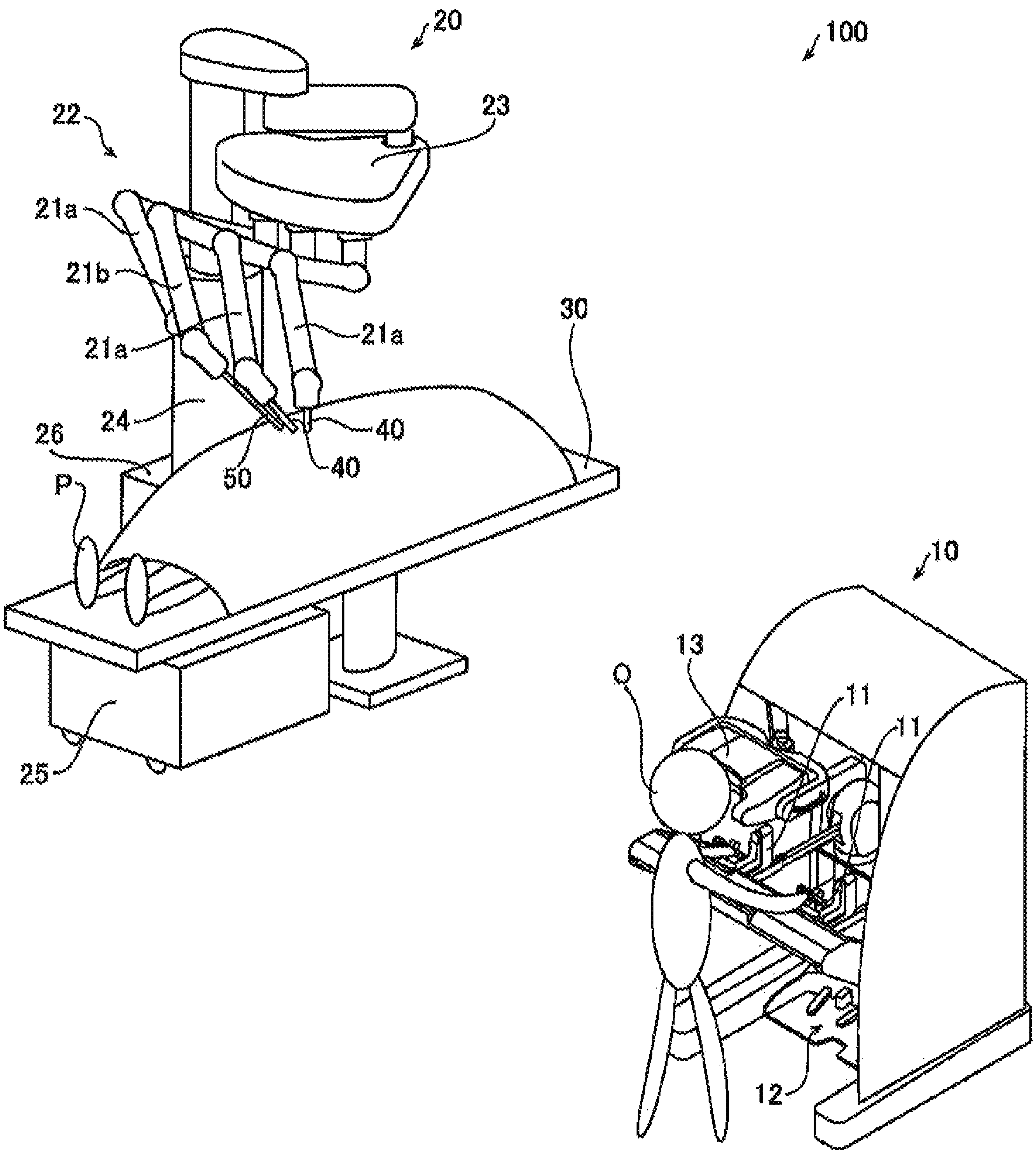
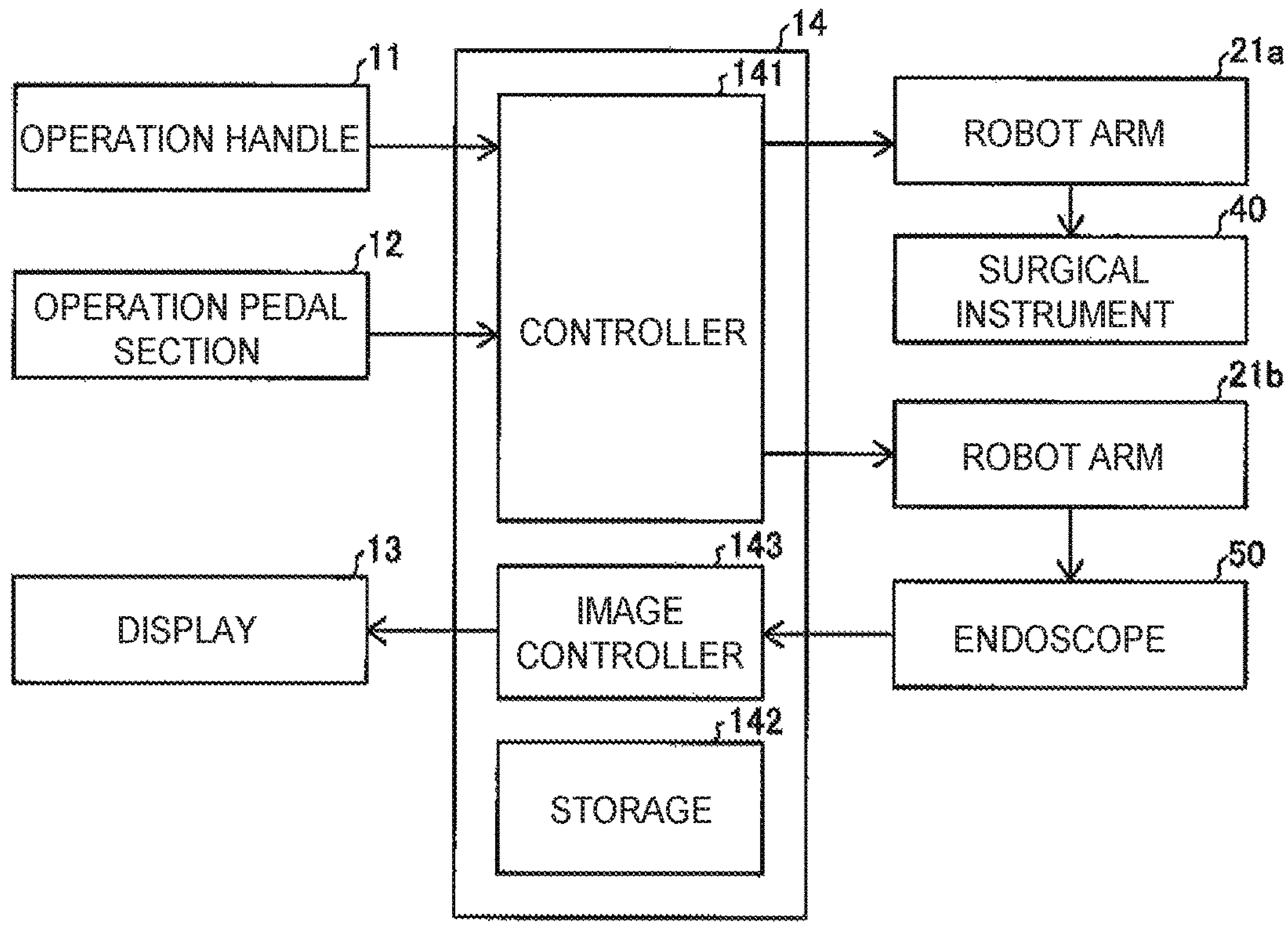


FIG. 2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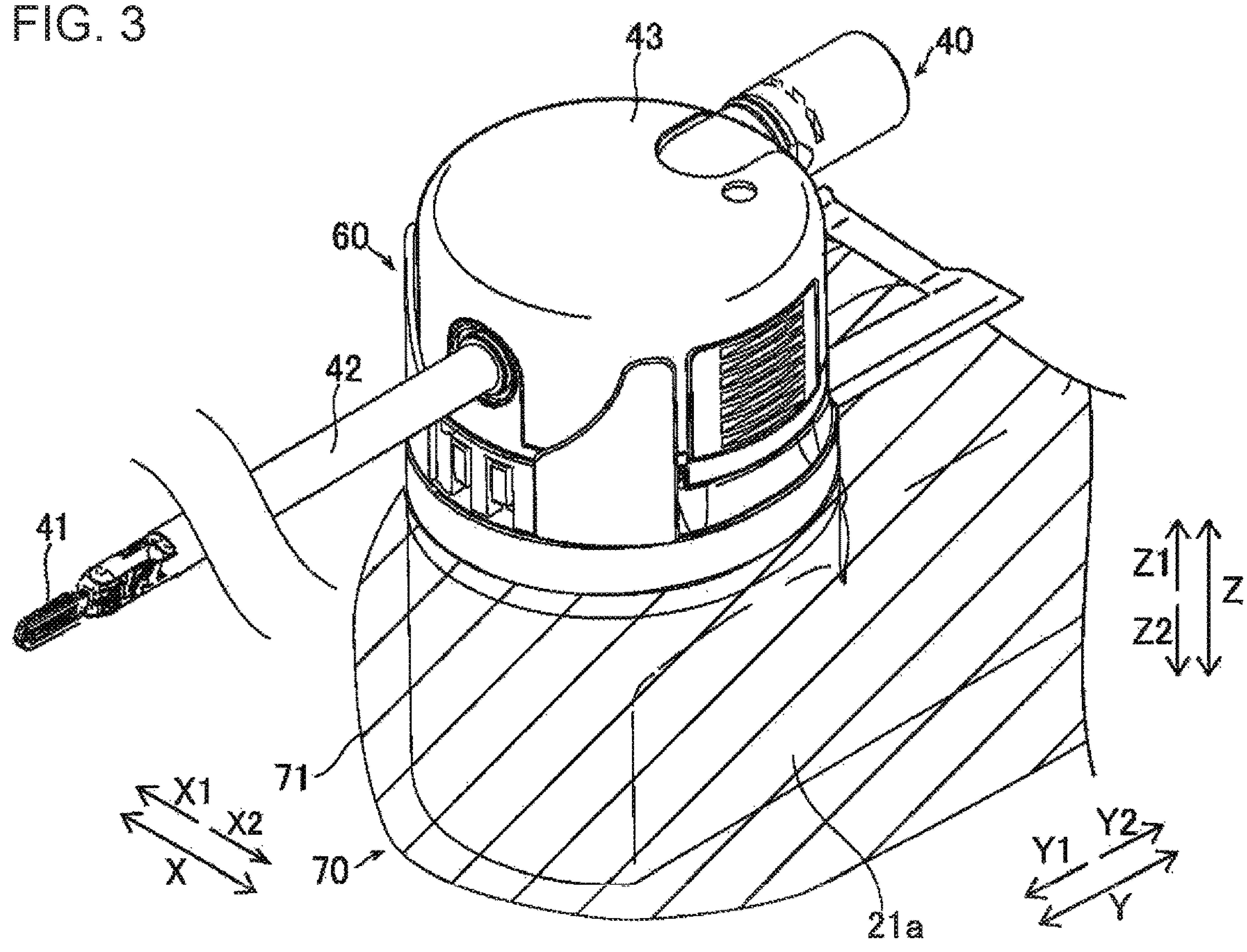
11
OPERATION HANDLE
141
CONTROLLER
21a
ROBOT ARM
40
SURGICAL INSTRUMENT
12
OPERATION PEDAL SECTION
21b
ROBOT ARM
13
DISPLAY
143
IMAGE CONTROLLER
50
ENDOSCOPE
142
STORAGE

FIG. 3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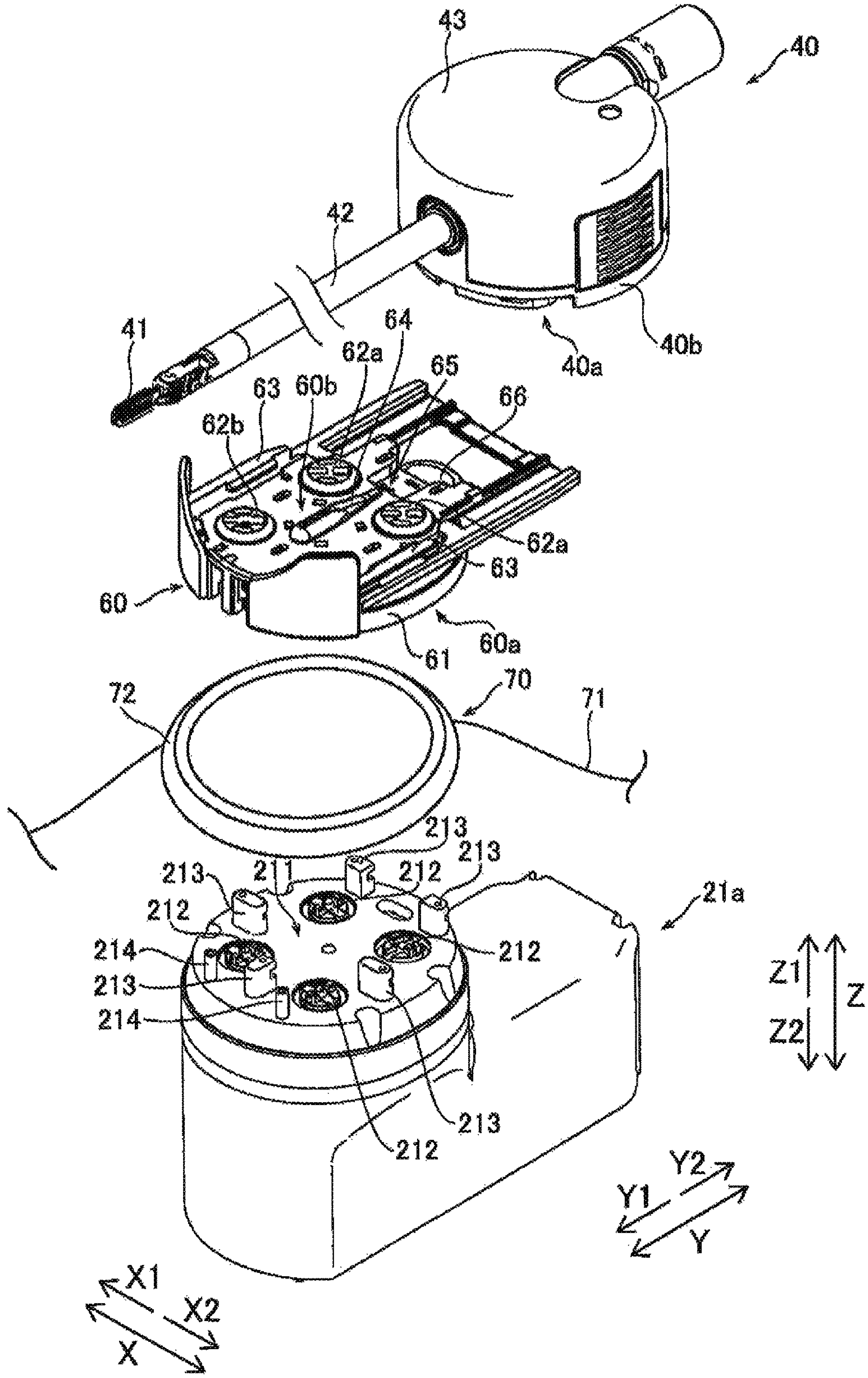
40
60
42
41
Z1
Z
Z2
71
X1
X2
X
70
21a
Y1
Y2
Y

FIG. 4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60b
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62b
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40b
62a
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60a
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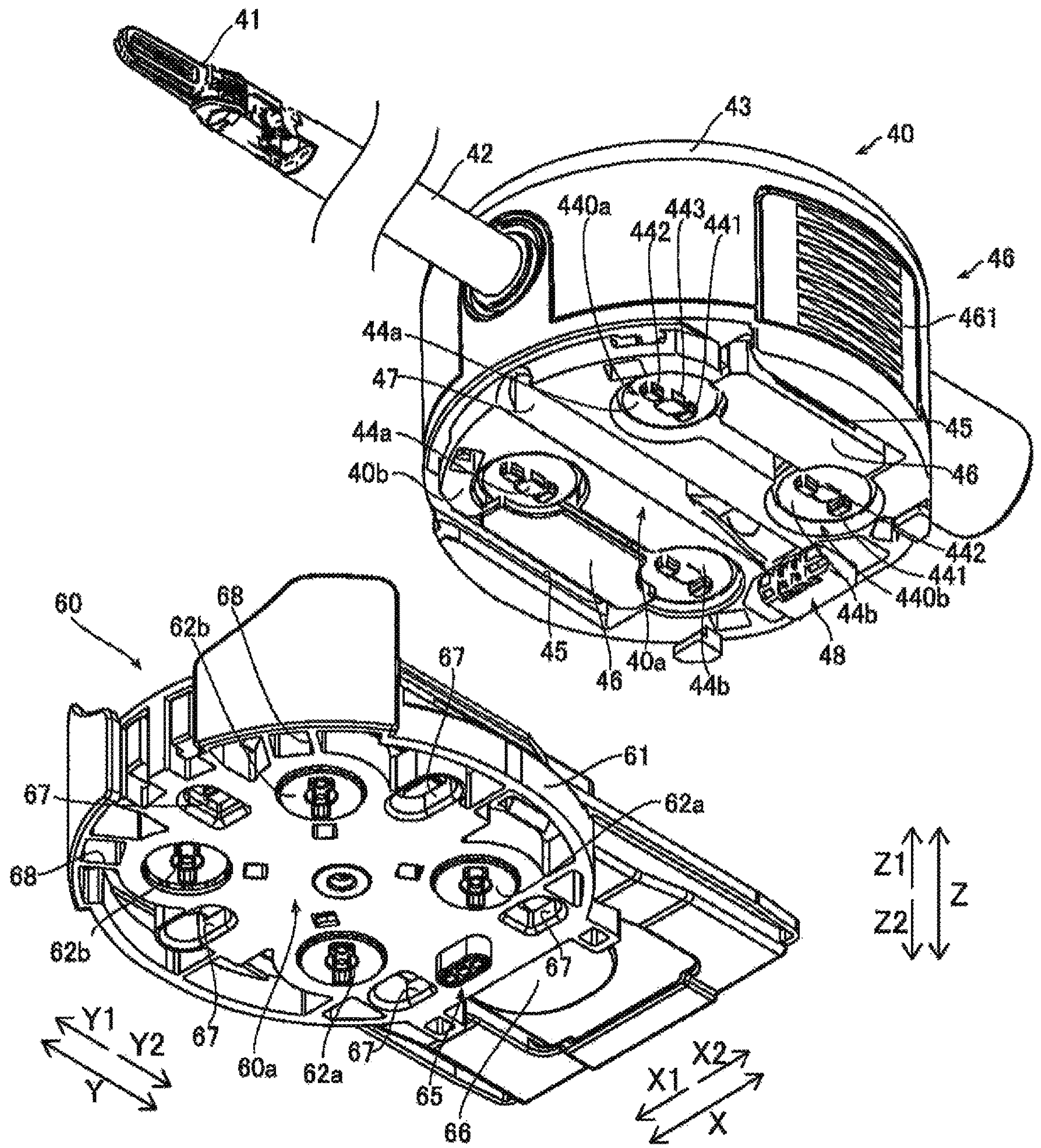
72
70
71
213
213
213
211
212
21a
212
213
214
212
213
214
Z1
Z
Z2
213
212
Y2
Y1
Y
X1
X2
X

FIG. 5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48
45
46
40a
44b
60
68
62b
67
61
67
62a
68
62b
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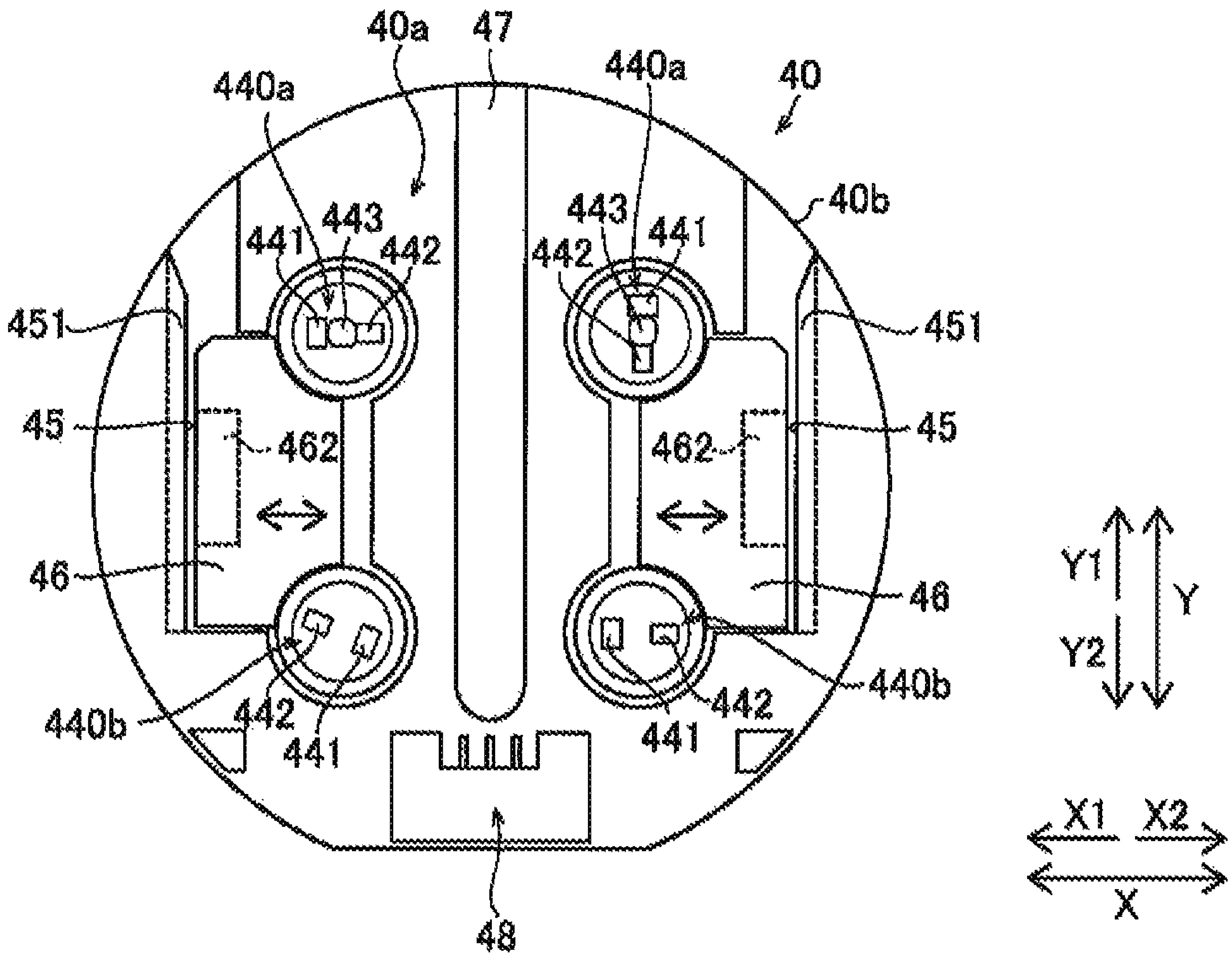
X1
X2
X

FIG. 6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40b
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462
462
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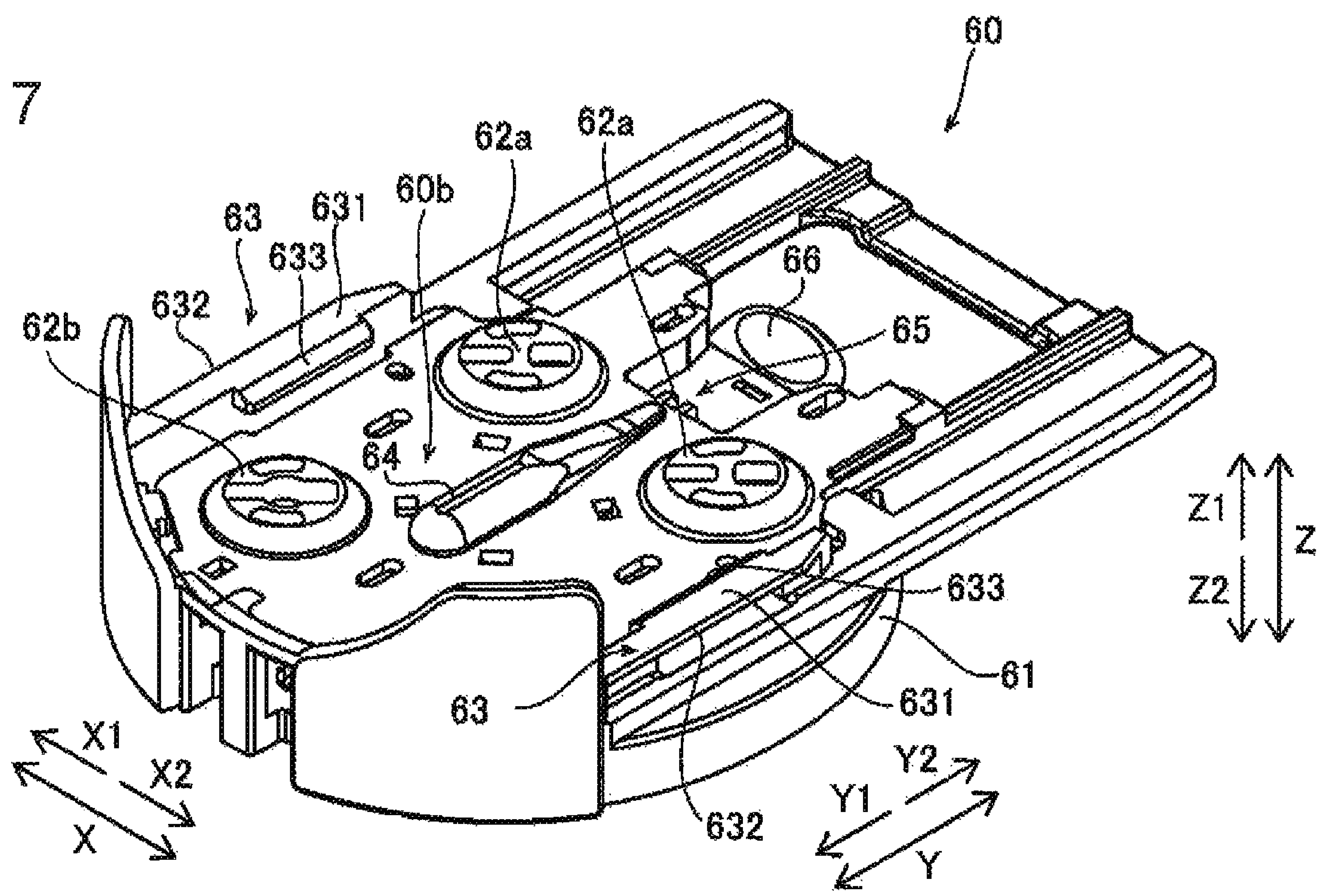
46
Y1
Y
Y2
440b
442
441
441
442
440b
X1
X2
X
48

FIG. 7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631
632
X1
X2
X
Y2
Y1
Y

FIG. 8

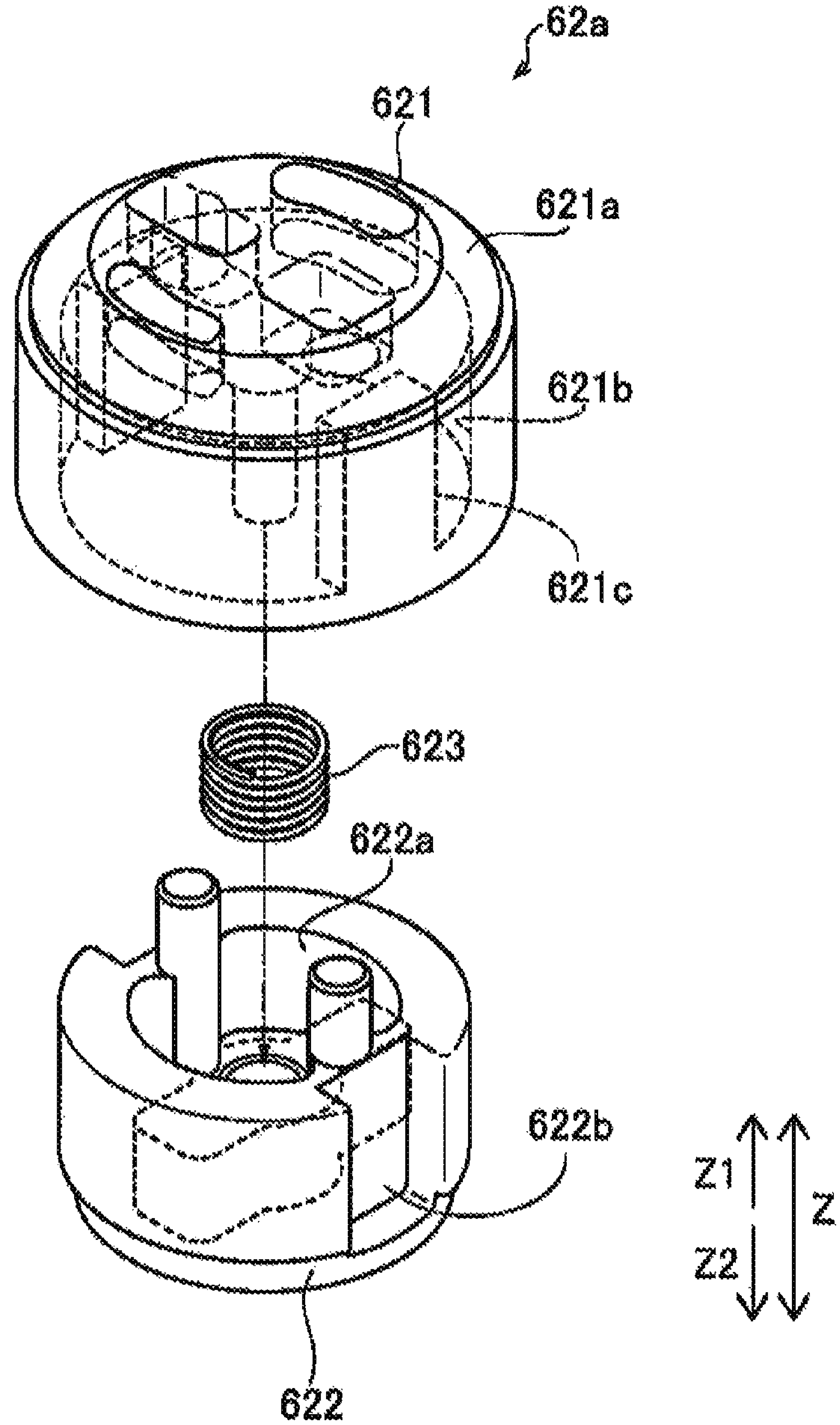
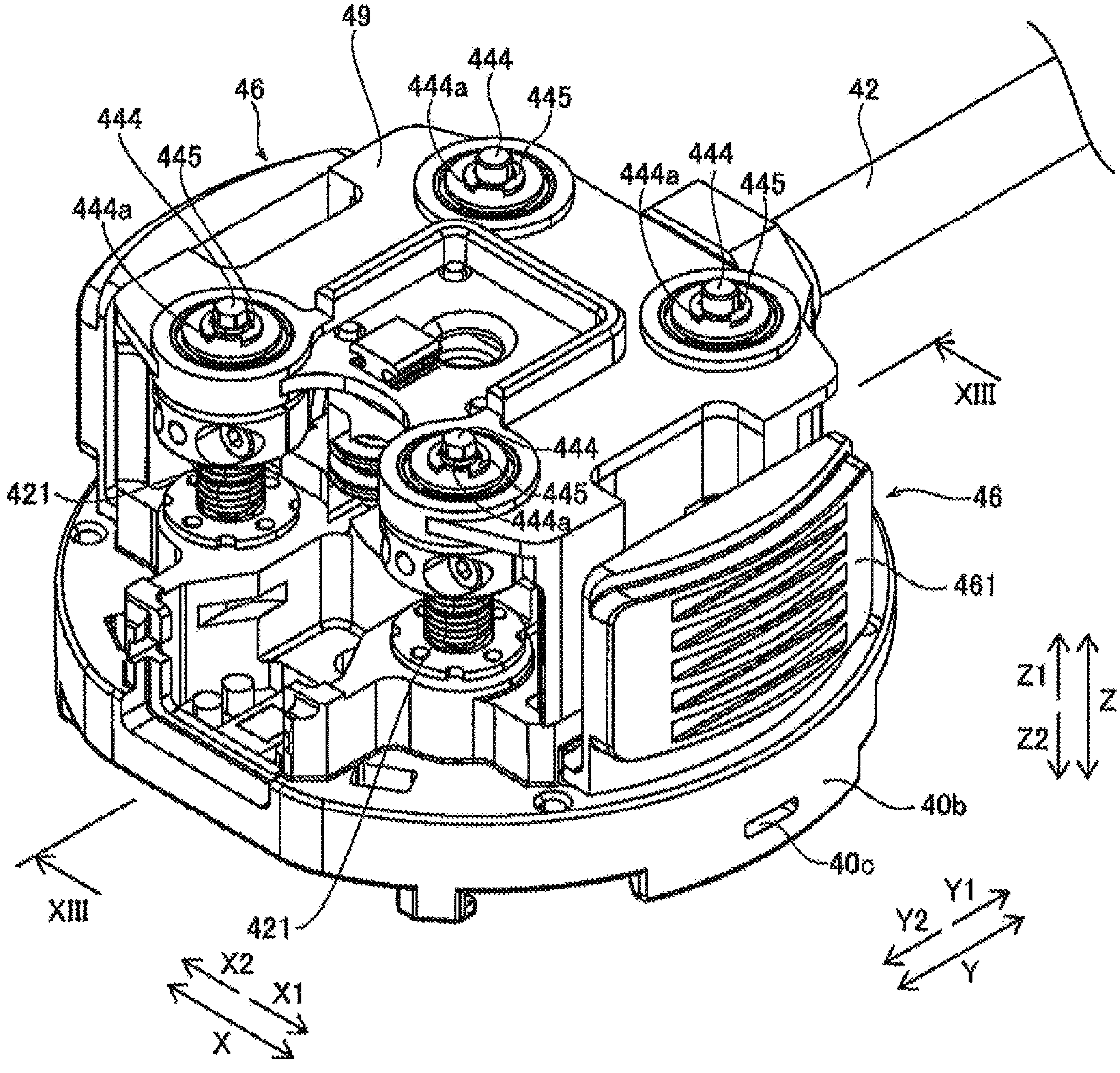


FIG. 9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444a
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42
444a
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445
XIII
444
421
445
444a
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461
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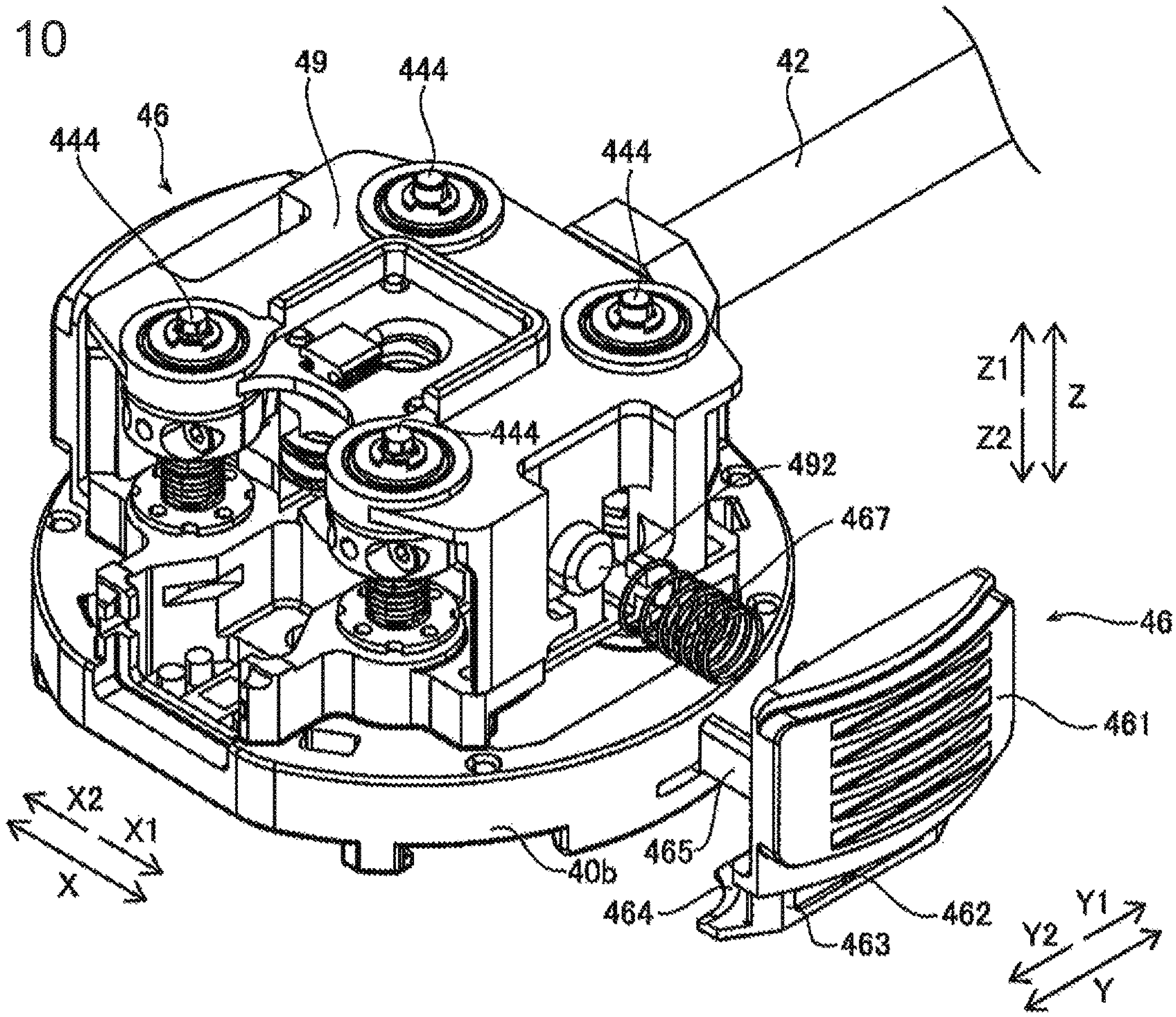
Z
Z2
40b
40c
XIII
421
Y1
Y2
Y
X2
X1
X

FIG. 10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Z1
Z
Z2
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X1
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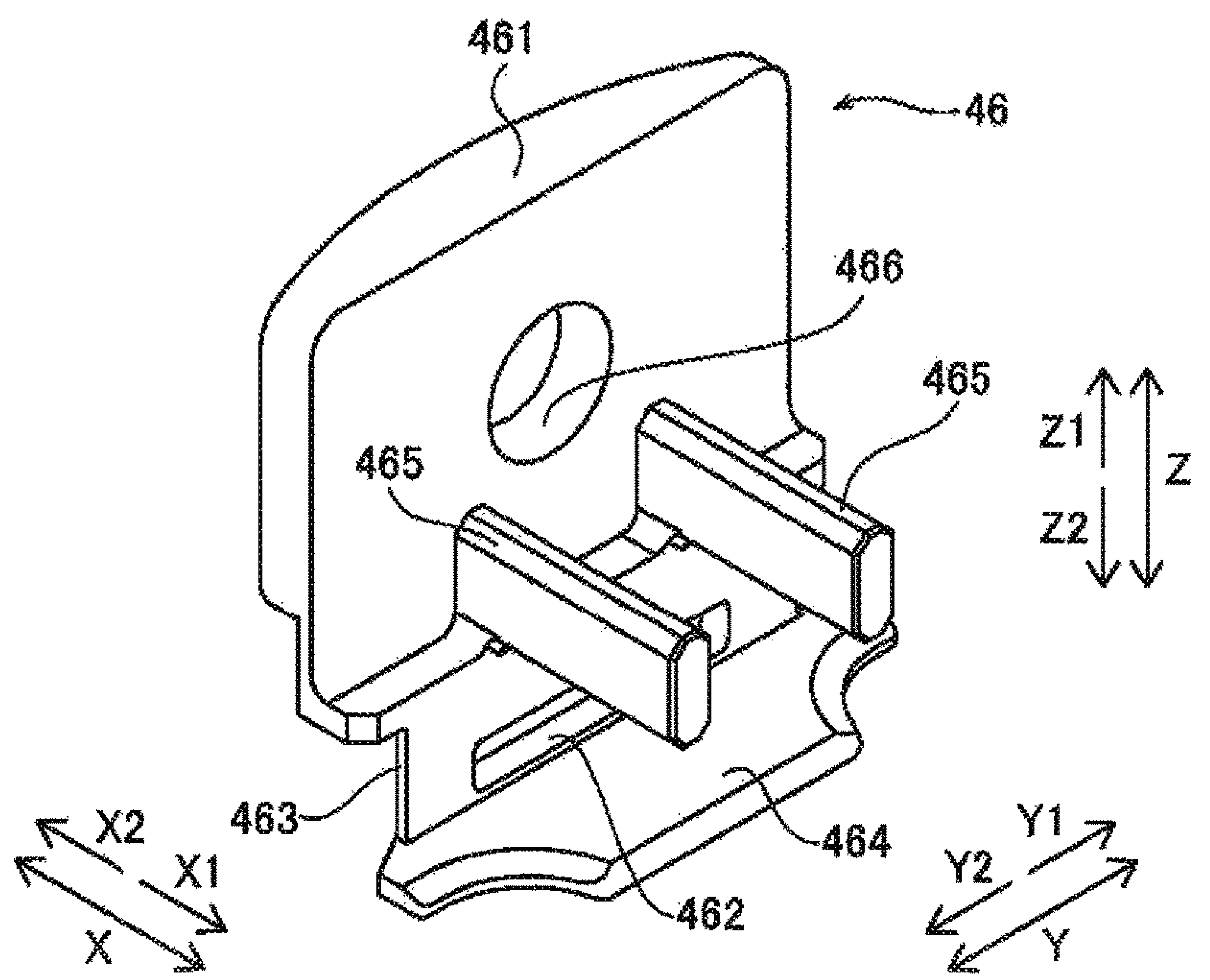
40b
464
462
463
Y1
Y2
Y

FIG. 11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X1
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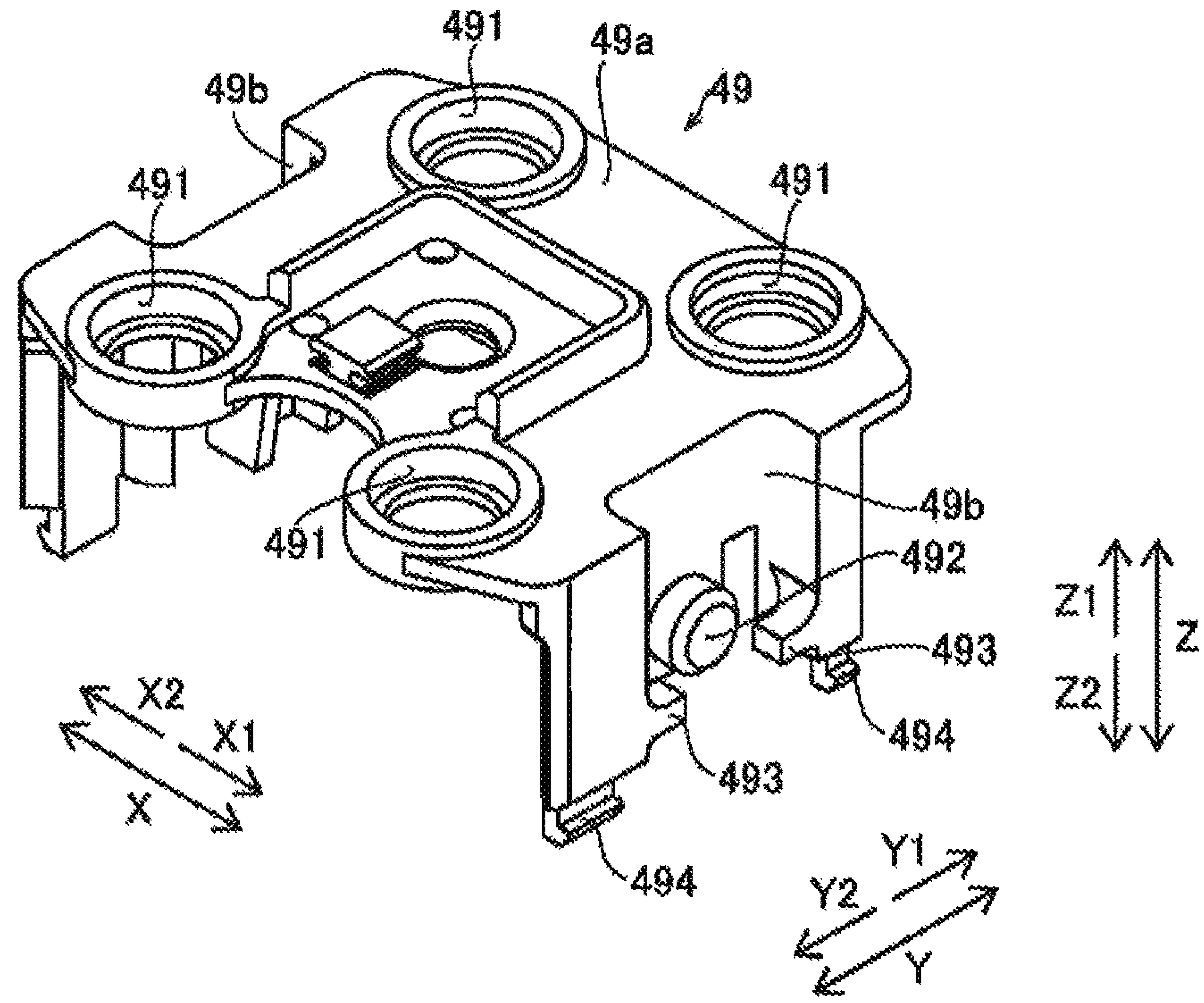
Y

FIG. 12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49b
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494
493
494
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Z
Z2
X2
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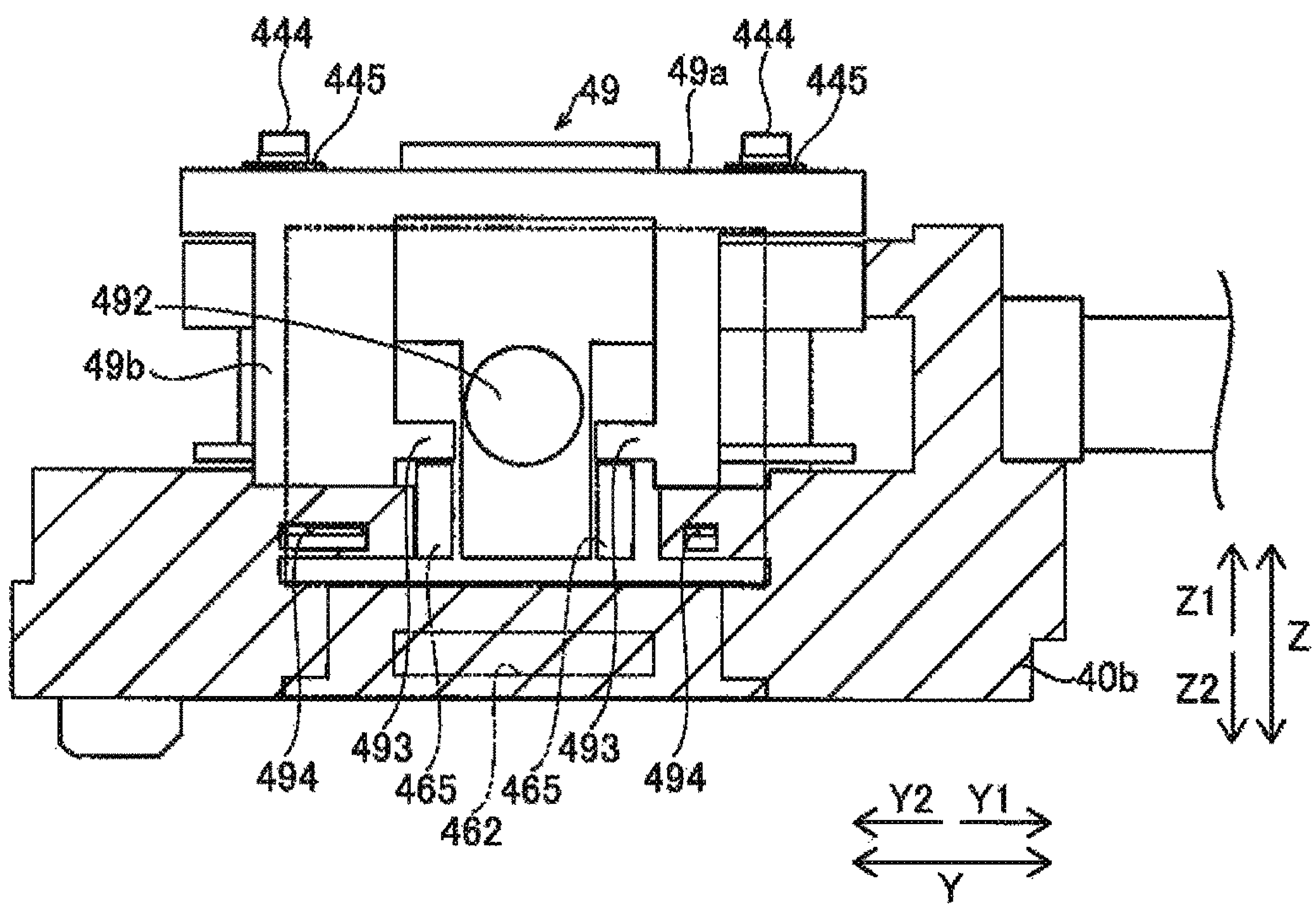
X
Y1
Y2
Y

FIG. 13


444
445
49
49a
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445
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49b
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Z2
40b
494
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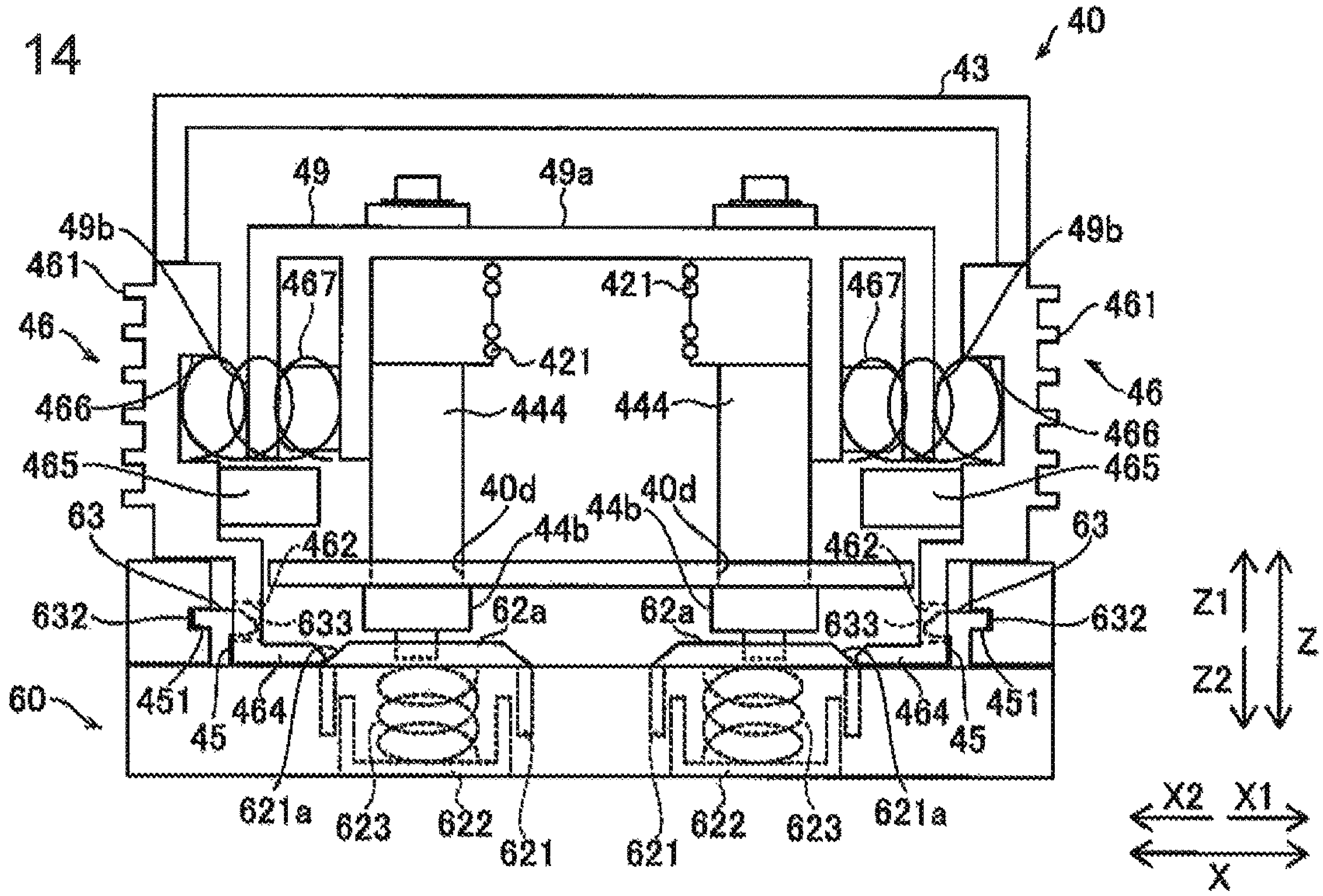
494
Y2
Y1
Y

FIG. 14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Z
Z2
60
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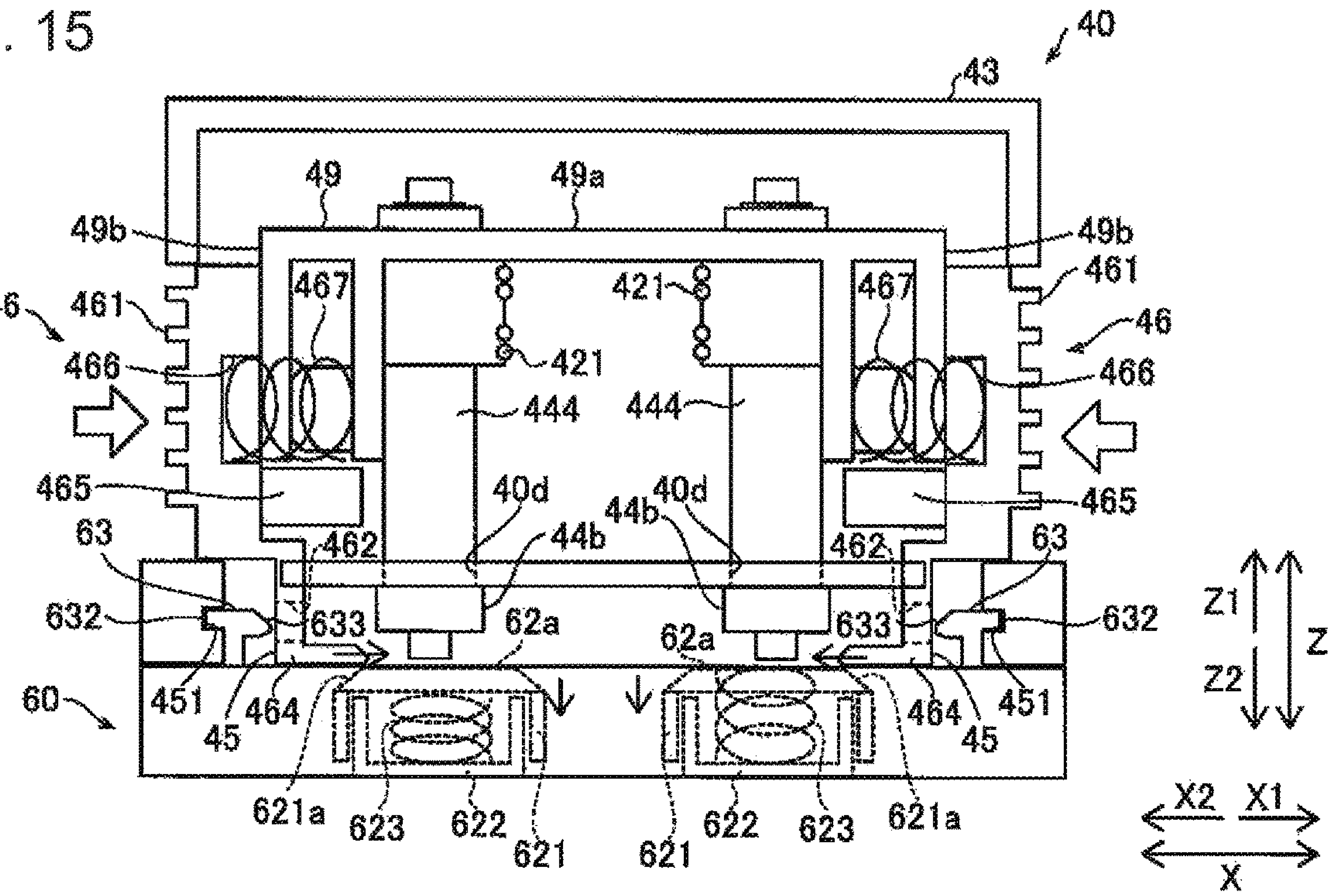
45
464
621a
623
622
621
X2
X1
X

FIG. 15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444
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40d
44b
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Z1
Z
Z2
60
451
45
464
621a
623
622
621
X2
X1
X

FIG. 16

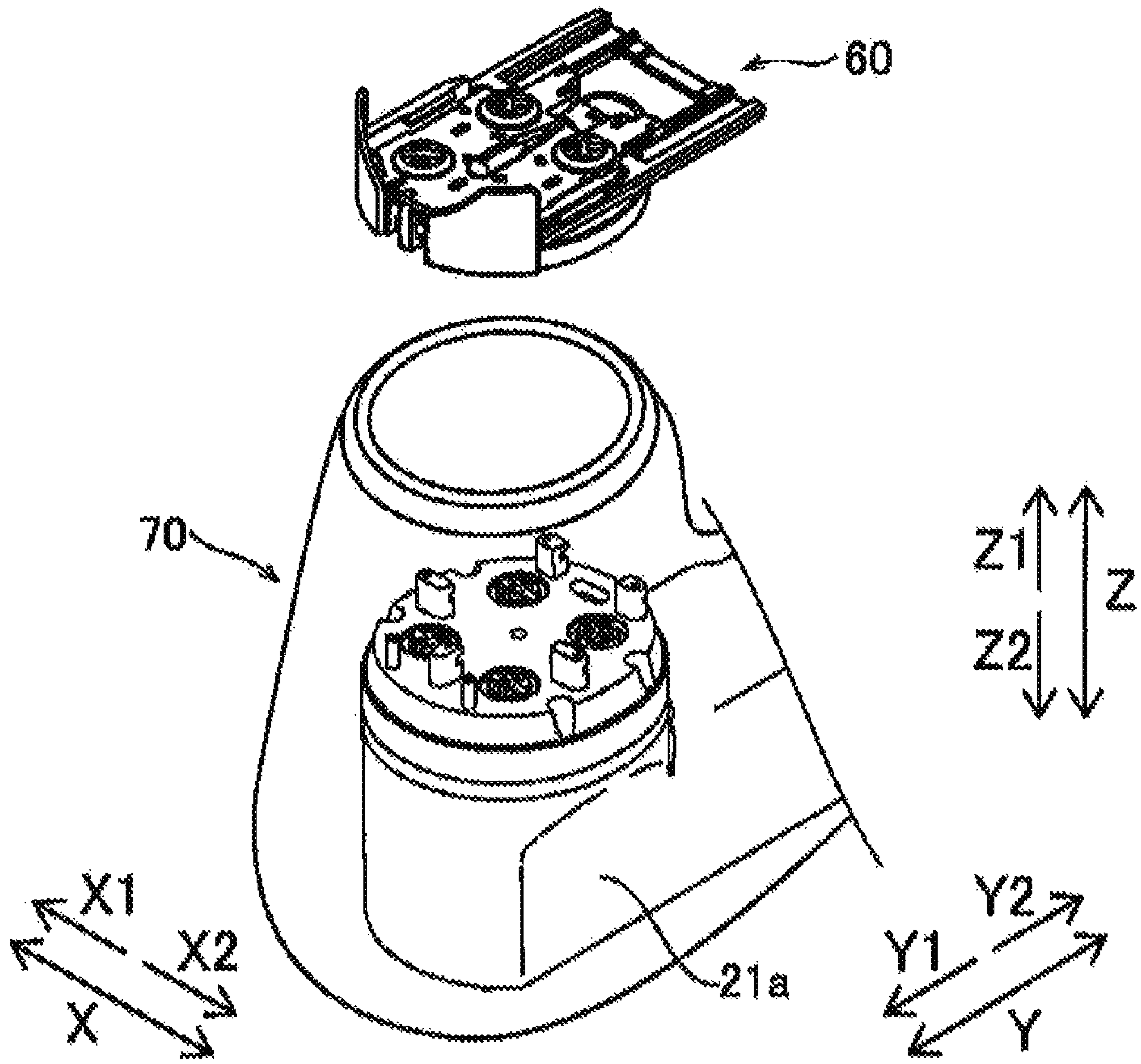


FIG. 17

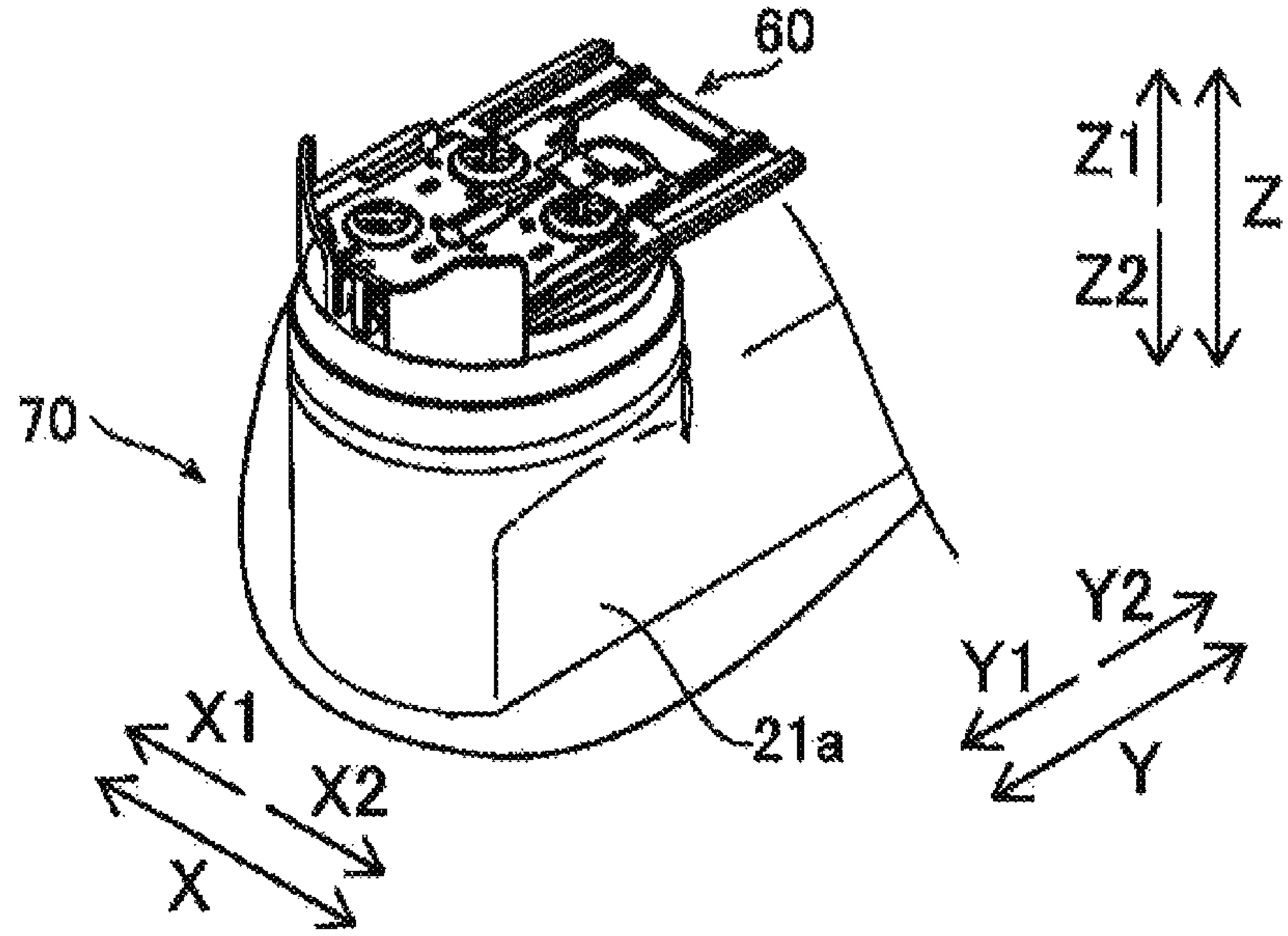
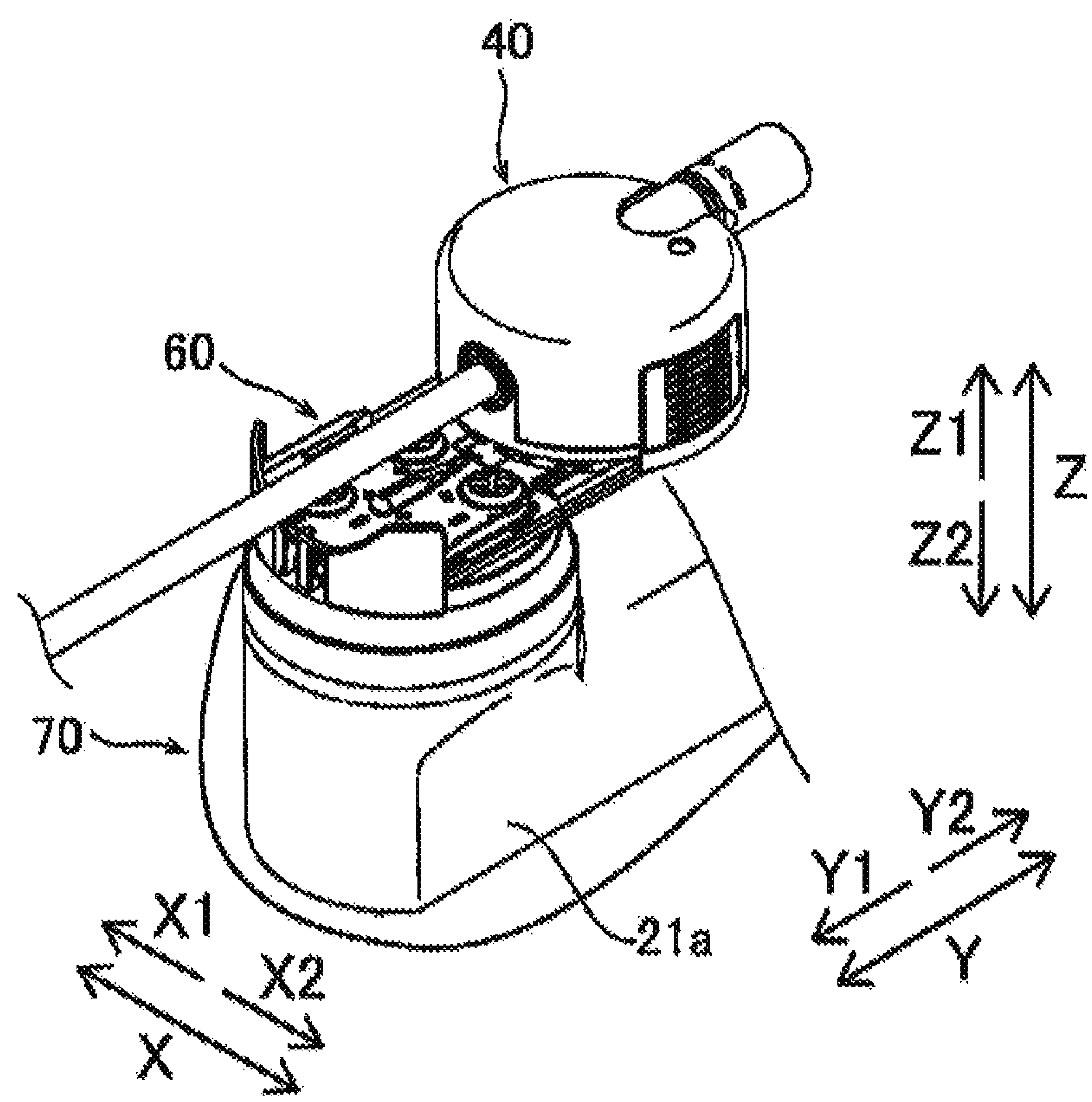


FIG. 18



SURGICAL INSTRUMENT, ASSEMBLY INCLUDING ADAPTOR AND SURGICAL INSTRUMENT, AND ROBOTIC SURGICAL SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority to Japanese Patent Application No. 2019-177054 filed on Sep. 27, 2019, the entire contents of which are incorporated herein by reference.

BACKGROUND

The disclosure relates to a surgical instrument, and may particularly relate to a surgical instrument to be detachably connected to a robot arm of a robotic surgical system through an adaptor, an assembly including the adaptor and the surgical instrument, and a robotic surgical system including the robot arm, the adaptor, and the surgical instrument.

In a related art, there has been known a surgical instrument to be detachably connected to a robot arm of a robotic surgical system through an adaptor.

U.S. Pat. No. 8,998,930 discloses a surgical instrument including: a base body that includes tabs to be engaged with a holding member of an adaptor and that is attached to the adaptor; a surgical tool; an elongated shaft including one end connected to the base body and the other end connected to the surgical tool; and driven members that are rotatably provided on the base body and connected with end portions of elongate elements for operating the surgical tool. This surgical instrument is configured, when attaching the surgical instrument to the adaptor, to slide the base body with respect to the adaptor so as to engage the tabs of the base body with the holding member of the adaptor. The surgical instrument is further configured, when detaching the surgical instrument from the adaptor, to slide the surgical instrument with respect to the adaptor in a direction opposite to the attachment direction, so as to disengage the tabs of the base body from the holding member of the adaptor.

SUMMARY

However, in the surgical instrument disclosed in U.S. Pat. No. 8,998,930, when detaching the surgical instrument from the adaptor, the tabs of the base body are disengaged from the holding member of the adaptor by sliding the surgical instrument in the direction opposite to the attachment direction. Thus, in a case where an engagement force between the tabs and the holding member is large, a large force may be needed to disengage the surgical instrument from the adaptor when detaching the surgical instrument from the adaptor. In this case, easy attachment and detachment of the surgical instrument to and from the adaptor may not be realized. On the other hand, in a case where the engagement force between the tabs and the holding member is small, a force of fixing the surgical instrument to the adaptor may be small. In this case, stable fixing of the surgical instrument to the adaptor may not be realized. Accordingly, the surgical instrument disclosed in U.S. Pat. No. 8,998,930 may have difficulties in achieving both the easy attachment and detachment of the surgical instrument to and from the adaptor and the stable fixing of the surgical instrument to the adaptor.

An object of an embodiment of the disclosure may be directed to a surgical instrument that is to be detachably connected to a robot arm of a robotic surgical system through an adaptor, wherein the surgical instrument is capable of being easily attached to and detached from the adaptor and capable of being stably fixed to the adaptor.

A first aspect of the disclosure may be a surgical instrument to be detachably connected to a robot arm of a robotic surgical system through an adaptor. The surgical instrument includes: a base body including an attachment surface to be attached to the adaptor; an elongated shaft including one end connected to the base body and the other end; a treatment tool provided on a side of the other end of the shaft, elongate elements for operating the surgical tool, driven members rotatably provided in the base body and connected with end portions of the elongate elements; a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and a movable member provided to be movable with respect to the holding member and the base body and engaged with the adaptor. The movable member is configured, when moved with respect to the holding member and the base body, to be disengaged from the adaptor.

A second aspect of the disclosure may be an assembly including an adaptor and a surgical instrument. The adaptor is to be attached to a robot arm of a robotic surgical system and the surgical instrument is to be detachably connected to the adaptor. The surgical instrument includes: a base body including an attachment surface to be attached to the adaptor; an elongated shaft including one end connected to the base body and the other end; a treatment tool provided on a side of the other end of the shaft, elongate elements for operating the surgical tool, driven members rotatably provided on the base body and connected with end portions of the elongate elements; a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and a movable member provided movable with respect to the holding member and the base body and engaged with an adaptor. The movable member is configured, when moved with respect to the holding member and the base body, to be disengaged from the adaptor.

A third aspect of the disclosure may be a robotic surgical system that may include: a robot arm; an adaptor that is attached to the robot arm; and a surgical instrument that is detachably connected to the adaptor. The surgical instrument includes: a base body including an attachment surface to be attached to the adaptor; an elongated shaft including one end connected to the base body and the other end; a treatment tool provided on a side of the other end of the shaft, elongate elements for operating the surgical tool, driven members rotatably provided in the base body and connected with end portions of the elongate elements; a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and a movable member provided movable with respect to the holding member and the base body and engaged with an adaptor. The movable member is configured, when moved with respect to the holding member and the base body, to be disengaged from the adaptor.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a diagram illustrating an overview of a robotic surgical system according to an embodiment;

FIG. **2** is a block diagram illustrating a view of a control-related configuration of the robotic surgical system according to an embodiment;

FIG. **3** is a diagram illustrating a perspective view of a state of an embodiment where a surgical instrument is attached to a robot arm through an adaptor;

FIG. **4** is a diagram illustrating a perspective view of a state of an embodiment where the adaptor and the surgical instrument are detached from the robot arm;

FIG. **5** is a diagram illustrating a perspective view of the surgical instrument and the adaptor according to an embodiment as seen from below;

FIG. **6** is a diagram illustrating a view of an attachment surface of the surgical instrument according to an embodiment as seen from below;

FIG. **7** is a diagram illustrating a perspective view of the adaptor according to an embodiment as seen from above;

FIG. **8** is a diagram illustrating an exploded perspective view of a drive transmission member of the adaptor according to an embodiment;

FIG. **9** is a diagram illustrating a perspective view of an inside of a housing of the surgical instrument according to an embodiment;

FIG. **10** is a diagram illustrating an exploded perspective view of a state where a movable member is detached from a base body of the surgical instrument according to an embodiment;

FIG. **11** is a diagram illustrating a perspective view of a movable member of the surgical instrument according to an embodiment;

FIG. **12** is a diagram illustrating a perspective view of a holding member of the surgical instrument according to an embodiment;

FIG. **13** is a diagram illustrating a cross sectional view along the XIII-XIII line in FIG. **9**;

FIG. **14** is a diagram illustrating a first explanatory view for explaining movement of the movable member of the surgical instrument according to an embodiment;

FIG. **15** is a diagram illustrating a second explanatory view for explaining the movement of the movable member of the surgical instrument according to an embodiment;

FIG. **16** is a diagram illustrating a first explanatory view for explaining attachment of the adaptor to the robot arm according to an embodiment;

FIG. **17** is a diagram illustrating a second explanatory view of attachment of the adaptor to the robot arm according to an embodiment; and

FIG. **18** is a diagram illustrating an explanatory view for explaining the attachment of the surgical instrument to the adaptor according to an embodiment.

DETAILED DESCRIPTION

Descriptions are provided hereinbelow for one or more embodiments based on the drawings. In the respective drawings referenced herein, the same constituents are designated by the same reference numerals and duplicate explanation concerning the same constituents is omitted. All of the drawings are provided to illustrate the respective examples only.

(Configuration of Robotic Surgical System)

A configuration of a robotic surgical system **100** according to an embodiment is described with reference to FIGS. **1** and **2**.

As illustrated in FIG. **1**, the robotic surgical system **100** includes a remote control apparatus **10** and a patient-side apparatus **20**.

The remote control apparatus **10** is provided to remotely control medical equipment provided for the patient-side apparatus **20**. When an operator O, as a surgeon, inputs an action mode instruction to be executed by the patient-side apparatus **20**, to the remote control apparatus **10**, the remote control apparatus **10** transmits the action mode instruction to the patient-side apparatus **20** through a controller **26**. In response to the action mode instruction transmitted from the remote control apparatus **10**, the patient-side apparatus **20** operates medical equipment such as surgical instruments **40**, an endoscope **50**, and the like, attached to robot arms **21***a* and **21***b*. This allows for minimally invasive surgery.

The patient-side apparatus **20** constitutes an interface to perform a surgery for a patient P. The patient-side apparatus **20** is positioned beside an operation table **30** on which the patient P is laid. The patient-side apparatus **20** includes plural robot arms **21***a* and **21***b*. One (**21***b*) of the robot arms holds the endoscope **50** and the other robot arms **21***a* hold the surgical instruments **40**. The robot arms **21***a* and **21***b* are commonly supported by a platform **23**. Each of the robot arms **21***a* and **21***b* includes plural joints. Each joint includes a driver provided with a servo-motor and a position detector such as an encoder. The robot arms **21***a* and **21***b* are configured so that the medical equipment attached to each robot arm **21***a* and **21***b* is controlled by a driving signal given through the controller **26** and performs a desired movement.

The platform **23** is supported by a positioner **22** placed on the floor of an operation room. The positioner **22** includes a column **24** and a base **25**. The column **24** includes an elevation shaft adjustable in the vertical direction. The base **25** includes wheels and is movable on the floor surface.

The surgical instruments **40** as the medical equipment is detachably attached to the distal ends of the robot arms **21***a*. Each surgical instrument **40** is detachably connected to the corresponding robot arm **21***a* of the robotic surgical system **100** through an adaptor **60** (see FIG. **3**). As illustrated in FIG. **4**, the surgical instrument **40** includes: a base body **40***b* including an attachment surface **40***a* to be attached to the adaptor **60**; an elongated shaft **42** including one end thereof connected to the base body **40***b* and the other end thereof; and an end effector **41** provided on the other end side of the shaft **42**. The end effector **41** is grasping forceps, scissors, a hook, a high-frequency knife, a snare wire, a clamp, or a stapler, for example. The end effector **41** is not limited to those and can be various types of treatment tools. In surgeries using the patient-side apparatus **20**, the robot arms **21***a* introduce the surgical instruments **40** into the body of the patient P through a cannula (trocar) placed on the body surface of the patient P. The end effectors **41** of the surgical instruments **40** are then located near the surgery site. Note that the end effector **41** is an example of a surgical tool.

To the distal end of the robot arm **21***b*, the endoscope **50** as the medical equipment is detachably attached. The endoscope **50** captures an image in a body cavity of the patient P. The captured image is outputted to the remote control apparatus **10**. The endoscope **50** is a 3D endoscope capable of capturing a three-dimensional image or a 2D endoscope. In surgeries using the patient-side apparatus **20**, the robot arm **21***b* introduces the endoscope **50** into the body of the patient P through a trocar placed on the body surface of the patient P. The endoscope **50** is then located near the surgery site.

The remote control apparatus **10** constitutes the interface with the operator O. The remote control apparatus **10** is an apparatus that allows the operator O to operate the medical equipment attached to the robot arms **21***a* and **21***b*. Specifically, the remote control apparatus **10** is configured to transmit action mode instructions which are inputted by the operator O and are to be executed by the surgical instruments **40** and endoscope **50**, to the patient-side apparatus **20** through the controller **26**. The remote control apparatus **10** is installed beside the operation table **30** so that the operator O can see the condition of the patient P very well while operating the remote control apparatus **10**, for example. The remote control apparatus **10** may be configured to transmit action mode instructions wirelessly and installed in a room different from the operation room where the operation table **30** is installed.

The action modes to be executed by the surgical instruments **40** include modes of actions to be taken by each surgical instrument **40** (a series of positions and postures) and actions to be executed by the function of each surgical instrument **40**. When the surgical instrument **40** is a pair of grasping forceps, for example, the action modes to be executed by the surgical instrument **40** include roll and pitch positions of the wrist of the end effector **41** and actions to open and close the jaws. When the surgical instrument **40** is a high-frequency knife, the action modes to be executed by the surgical instrument **40** include vibration of the high-frequency knife, specifically, supply of current to the high-frequency knife. When the surgical instrument **40** is a snare wire, the action modes to be executed by the surgical instrument **40** include a capturing action and an action to release the captured object. Further the action modes may include an action to supply current to a bipolar or monopolar instrument to burn off the surgery site.

The action modes to be executed by the endoscope **50** include the position and posture of the tip of the endoscope **50** and setting of the zoom magnification, for example.

As illustrated in FIGS. **1** and **2**, the remote control apparatus **10** includes operation handles **11**, an operation pedal section **12**, a display section **13**, and a control apparatus **14**.

The operation handles **11** are provided in order to remotely operate the medical equipment attached to the robot arms **21***a* and **21***b*. Specifically, the operation handles **11** accept operations by the operator O for operating the medical equipment (the surgical instruments **40** and endoscope **50**). The operation handles **11** include two operation handles **11** arranged side by side in the horizontal direction. One of the two operation handles **11** is operated by the right hand of the operator O while the other operation handle **11** is operated by the left hand of the operator O.

The operation handles **11** extend from the rear side of the remote control apparatus **10** toward the front side. The operation handles **11** are configured to move in a predetermined three-dimensional operation region. Specifically, the operation handles **11** are configured so as to move up and down, right and left, and forward and rearward.

The remote control apparatus **10** and patient-side apparatus **20** constitute a master-slave system in terms of controlling movement of the robot arms **21***a* and robot arm **21***b*. The operation handles **11** constitute an operating section or an operating part on the master side in the master-slave system, and the robot arms **21***a* and **21***b* holding the medical equipment constitute an operating section or an operation part on the slave side. When the operator O operates the operation handles **11**, the movement of one of the robot arms **21***a* or **21***b* is controlled so that the distal end portion (the end effector **41** of the surgical instrument **40**) of the robot arm **21***a* or the distal end portion (the endoscope **50**) of the robot arm **21***b* moves following the movement of the operation handles **11**.

The patient-side apparatus **20** controls the movement of the robot arms **21***a* in accordance with the set motion scaling ratio. When the motion scaling ratio is set to ½, for example, the end effectors **41** of the surgical instruments **40** move ½ of the movement distance of the operation handles **11**. This allows for precise fine surgery.

The operation pedal section **12** or an operation pedal unit includes plural pedals to execute medical equipment-related functions. The plural pedals include a coagulation pedal, a cutting pedal, a camera pedal, and a clutch pedal. The plural pedals are operated by a foot of the operator O.

The coagulation pedal enables the surgical instrument **40** to coagulate a surgery site. Specifically, when the coagulation pedal is operated, voltage for coagulation is applied to the surgical instrument **40** to coagulate a surgery site. The cutting pedal enables the surgical instrument **40** to cut a surgery site. Specifically, the cutting pedal is operated to apply voltage for cutting to the surgical instrument **40** and cut a surgery site.

The camera pedal is used to control the position and orientation of the endoscope **50** that captures images within the body cavity. Specifically, the camera pedal enables operation of the endoscope **50** by the operation handles **11**. That is, the position and orientation of the endoscope **50** are controllable by the operation handles **11** while the camera pedal is being pressed. The endoscope **50** is controlled by using both of the right and left operation handles **11**, for example. Specifically, when the operator O rotates the right and left operation handles **11** about the middle point between the right and left operation handles **11**, the endoscope **50** is rotated. When the operator O presses the right and left operation handles **11** together, the endoscope **50** goes forward into the body cavity. When the operator O pulls the right and left operation handles **11** together, the endoscope **50** goes back. When the operator O moves the right and left operation handles **11** together up, down, right, or left, the endoscope **50** moves up, down, right, or left, respectively.

The clutch pedal is used to temporarily disconnect operation-related connection between the operation handles **11** and the robot arms **21***a* to stop movement of the surgical instruments **40**. Specifically, when the clutch pedal is being pressed, the robot arms **21***a* of the patient-side apparatus **20** do not work even if the operation handles **11** are operated. For example, when the operation handles **11** are operated and moved to the edge of the range of movement, the operator O operates the clutch pedal to temporarily disconnect the operation-related connection and then returns the operation handles **11** to the center of the range of movement. When the operator O stops operating the clutch pedal, the operation handles **11** are again connected to the robot arms **21***a*. The operator O restarts the operation for the operation handles **11** around the center thereof.

The display section **13** or a display unit is configured to display images captured by the endoscope **50**. The display section **13** includes a scope type display section or a non-scope type display section. The scope type display section is a display section that the operator O looks into. The non-scope type display section is an open-type display section that includes a flat screen and the operator O is able to see without looking into, such as normal displays for personal computers.

When the scope type display section is attached, the scope type display section displays 3D images captured by the endoscope **50** attached to the robot arm **21***b* of the patient-side apparatus **20**. When the non-scope type display section is attached, the non-scope type display section also displays 3D images captured by the endoscope **50** provided for the patient-side apparatus **20**. The non-scope type display section may display 2D images captured by the endoscope **50** provided for the patient-side apparatus **20**.

As illustrated in FIG. **2**, the control apparatus **14** includes a controller **141**, a storage **142**, and an image controller **143**, for example. The controller **141** includes a calculator such as a CPU. The storage **142** includes a memory, such as a ROM and a RAM. The control apparatus **14** may be composed of a single controller performing centralized control or may be composed of plural controllers that perform decentralized control in cooperation with each other. The controller **141** determines whether an action mode instruction inputted by the operation handles **11** is to be executed by the robot arms **21***a* or to be executed by the endoscope **50**, depending on the state of the operation pedal section **12**. When determining that the action mode instruction inputted by the operation handles **11** is to be executed by any one of the surgical instruments **40**, the controller **141** transmits the action mode instruction to the corresponding robot arm **21***a*. The robot arm **21***a* is thereby driven for controlling movement of the surgical instrument **40** attached to the robot arm **21***a*.

When determining that the action mode instruction inputted by the operation handles **11** is to be executed by the endoscope **50**, the controller **141** transmits the action mode instruction to the robot arm **21***b*. The robot arm **21***b* is thereby driven for control of movement of the endoscope **50** attached to the robot arm **21***b*.

The storage **142** stores control programs corresponding to the types of the surgical instrument **40**, for example. The controller **141** reads the stored control programs according to the types of the attached surgical instruments **40**. The action mode instructions from the operation handles **11** and/or the operation pedal section **12** of the remote control apparatus **10** thereby cause the respective surgical instruments **40** to perform proper movements.

The image controller **143** transmits images acquired by the endoscope **50** to the display section **13**. The image controller **143** performs processing and modifying the images when needed.

(Configurations of Adaptor and Surgical Instrument)

With reference to FIGS. **3** to **15**, the configurations of an adaptor **60** and the surgical instrument **40** according to an embodiment are described.

As illustrated in FIG. **3**, each of the robot arms **21***a* is used in a clean area and is covered with a drape **70**. In operation rooms, clean technique is used in order to prevent surgical incision sites and the medical equipment from being contaminated by pathogen, foreign matters, or the like. The clean technique defines a clean area and a contaminated area, which is other than the clean area. The surgery sites are located in the clean area. Members of the surgical team, including the operator O, make sure that only sterile objects are placed in the clean area during surgery and perform sterilization for an object which is to be moved to the clean area from the contaminated area. Similarly, when the members of the surgical team including the operator O place their hands in the contaminated area, the members sterilize their hands before directly touching objects located in the clean area. Instruments used in the clean area are sterilized or are covered with sterile drape **70**.

The drape **70** is arranged between the robot arm **21***a* and the surgical instrument **40**. Specifically, the drape **70** is arranged between the adaptor **60** and the robot arm **21***a*. Further, the drape **70** is arranged between the robot arm **21***b* and the endoscope **50**. The adaptor **60** is attached to the robot arm **21***a* while putting the drape **70** between the adaptor **60** and the robot arm **21***a*. Specifically, the adaptor **60** is a drape adaptor that puts the drape **70** between the adaptor **60** and the robot arm **21***a*. The surgical instrument **40** is attached to the adaptor **60** that is attached to the robot arm **21***a* with the drape **70** interposed therebetween. The robot arm **21***a* transmits driving force to the surgical instrument **40** through the adaptor **60** to drive the end effector **41** of the surgical instrument **40**.

As illustrated in FIG. **4**, the adaptor **60** includes a base body **61**, drive transmission members **62***a* and **62***b*, a pair of guide rails **63**, a precedence guide rail **64**, an electrode array **65**, and an arm engagement portion **66**. As illustrated in FIG. **5**, the adaptor **60** includes arm engagement holes **67** and positioning holes **68**. As illustrated in FIG. **4**, of the drive transmission members **62***a* and **62***b*, the drive transmission members **62***a* are arranged in the Y2 side and the drive transmission members **62***b* are arranged in the Y1 side. In the adaptor **60**, a first surface **60***a* is arranged in the Z2 side and attached to the robot arm **21***a*. The adaptor **60** includes a second surface **60***b* arranged in the Z1 side to which the surgical instrument **40** is attached.

The surgical instrument **40** is a surgical instrument that is detachably connected to the robot arm **21***a* of the robotic surgical system **100** through the adaptor **60**. As illustrated in FIG. **5**, an attachment surface **40***a* arranged in the Z2 side of the housing **43** of the surgical instrument **40** is attached to the adaptor **60**. The surgical instrument **40** includes: plural driven members **44***a* and **44***b*; a pair of guide grooves **45**; a pair of movable members **46**; a precedence guide groove **47**; and an electrode array **48**. Of the driven members **44***a* and **44***b*, the driven members **44***a* are provided on the Y1 side and the driven member **44***b* are provided on the Y2 side. The surgical instrument **40** includes a base body **40***b* that includes the attachment surface **40***a* relative to the adaptor **60**.

As illustrated in FIG. **4**, the drape **70** includes a body part **71** and an attachment section **72**. The body part **71** is made in a film form. The attachment section **72** is made by resin molding. The attachment section **72** includes a through-opening at a portion where the robot arm **21***a* is engaged with the adaptor **60**. The through-opening may be provided corresponding to each of plural engagement portions. The through-openings may be provided corresponding to the plural engagement portions.

The adaptor **60** is attached to an adaptor attachment surface **211** of the robot arm **21***a*. The robot arm **21***a* includes rotation drive parts **212**, engagement portions **213**, and bosses **214**.

As illustrated in FIG. **5**, the driven members **44***a* and **44***b* of the surgical instrument **40** are driven to be rotated and thus drive the end effector **41**. Specifically, one end (an end portion on the Y2 side) of the shaft **42** is connected to the base body **40***b*, and the other end (an end portion on the Y1 side) of the shaft **42** is connected to the end effector **41**. The driven members **44***a* and **44***b* are connected to the end effector **41** with wires **421** (see FIG. **9**) inserted through the shaft **42**. Specifically, the driven members **44***a* and **44***b* are rotatably provided in the base body **40***b*. End portions of the wires **421** for operating the end effector **41** are connected to the driven members **44***a* and **44***b*, respectively. With the driven members **44***a* and **44***b* being rotated, the wires **421** are drawn to drive the end effector **41**. In the housing **43**, the driven members **44***a* and **44***b* are connected to the shaft **42** through gears. Specifically, the housing **43** is provided on the base body **40***b* to cover the driven members **44***a* and **44***b*. With the driven members **44***a* and **44***b* being rotated, the shaft **42** is rotated. The wires **421** are an example of elongate elements. The elongate elements may be cables, rods, or bunds, or the like.

As illustrated in FIG. **5**, for example, the number of the driven members **44***a* is two, and the number of the driven members **44***b* is two. With one of the driven members **44***a* being rotated, the shaft **42** is rotated. With one or more of the other three driven members **44***a* and **44***b* being rotated, the end effector **41** is driven. The four driven members **44***a* and **44***b* are arranged such that two rows of them are arranged in the X direction while two columns of them are arranged in the Y direction.

As illustrated in FIGS. **5** and **6**, each of the driven members **44***a* includes an engagement portion **440***a* that is engaged with the corresponding drive transmission member **62***b* provided in the adaptor **60**. Each of the driven members **44***b* includes an engagement portion **440***b* that is engaged with the corresponding drive transmission member **62***a* provided in the adaptor **60**. The engagement portion **440***a* is provided at the driven member **44***a* provided on the upstream side of the slide insertion direction (the Y1 side). The engagement portion **440***b* is provided at the driven member **44***b* provided on the downstream side of the slide insertion direction (the Y2 side). The engagement portion **440***a* and the engagement portion **440***b* have different shapes.

Specifically, the engagement portion **440***a* includes a first projection **441**, a second projection **442** provided separately from the first projection **441**, and a third projection **443** arranged between the first projection **441** and the second projection **442**. The engagement portion **440***b* includes no third projection **443** but the first projection **441** and the second projection **442**.

The pair of guide grooves **45** are provided on the attachment surface **40***a* of the base body **40***b*. The pair of guide grooves **45** is provided for slidably receiving the pair of guide rails **63** provided on the adaptor **60**. Each of the guide grooves **45** is provided to extend along the Y direction. The pair of guide grooves **45** are provided to be opposed to each other in the X direction. The pair of guide grooves **45** are provided substantially parallel to each other. With the pair of guide rails **63** of the adaptor **60** being inserted in the pair of guide grooves **45**, the pair of guide grooves **45** guide the attachment to the adaptor **60**.

At least a part of each of the guide grooves **45** is defined by the corresponding one of the movable members **46**. Specifically, the guide groove **45** is defined by the base body **40***b* and the corresponding movable member **46**. The movable members **46** are movably provided with respect to the base body **40***b* and the holding member **49** (see FIG. **9**). The movable member **46** is configured to release the engagement with the adaptor **60** by moving with respect to the base body **40***b* and the holding member **49**. The movable members **46** are configured to change the groove widths of the guide grooves **45**, by moving the movable members **46** with respect to the base body **40***b* and the holding member **49**. Specifically, the width of each guide groove **45** is varied according to movement in the X direction of the corresponding movable member **46**. Specifically, when the movable member **46** is moved inward, the width of the guide groove **45** is increased. When the movable member **46** is moved outward, the width of the guide groove **45** is decreased. The movable member **46** is biased to a direction (an outward direction) in which the width of the guide groove **45** is decreased.

The groove widths of the guide grooves **45** can be varied by moving the movable members **46**. Consequently, it is possible to easily attach and detach the surgical instrument **40** to and from the adaptor **60** by sliding the guide grooves **45** having the increased groove widths with respect to the guide rails **63** of the adaptor **60**. Additionally, the base body **40***b* of the surgical instrument **40** can be engaged with and fixed to the adaptor **60** by decreasing the groove widths of the guide grooves **45** after inserting the guide rails **63** of the adaptor **60** in the guide grooves **45**. Consequently, it is possible to stably fix the surgical instrument **40** to the adaptor **60**. Therefore, in the surgical instrument **40**, which is to be detachably connected to the robot arm **21***a* of the robotic surgical system **100** through the adaptor **60**, can be easily attached to and detached from the adaptor **60** and can be stably fixed to the adaptor **60**.

The precedence guide groove **47** is provided to extend along the Y direction. The precedence guide groove **47** is provided between the pair of guide grooves **45**. The precedence guide groove **47** is formed to extend substantially parallel to the pair of guide grooves **45**. The precedence guide groove **47** is provided in the substantial center in the X direction of the attachment surface **40***a*.

The electrode array **48** is connected to the robot arm **21***a* through the electrode array **65** of the adaptor **60**. The electrode array **48** is connected to a board provided in the housing **43**. Specifically, the board of the surgical instrument **40** is connected to the robot arm **21***a* by attaching the surgical instrument **40** to the robot arm **21***a* through the adaptor **60**. The board in the housing **43** is used for, for example, managing types of the surgical instrument **40** and the number of uses of the surgical instrument **40**.

As illustrated in FIG. **4**, the adaptor **60** is provided to detachably connect the surgical instrument **40** to the robot arm **21***a* of the robotic surgical system **100**.

The drive transmission members **62***a* and **62***b* are rotatably provided to the base body **61** of the adaptor **60**. Specifically, the drive transmission members **62***a* and **62***b* are provided to be rotatable about rotational axes thereof extending in the Z direction. The drive transmission members **62***a* and **62***b* transmit driving force of the rotation drive parts **212** of the robot arm **21***a* to the driven members **44***b* and **44***a* of the surgical instrument **40**. The plural drive transmission members **62***a* and **62***b* are provided corresponding to the driven members **44***b* and **44***a* of the surgical instrument **40**. The plural drive transmission members **62***a* and **62***b* are respectively arranged in positions corresponding to the driven members **44***b* and **44***a* of the surgical instrument **40**.

As illustrated in FIG. **7**, the guide rails **63** are provided on the second surface **60***b* of the adaptor **60**. The guide rails **63** are provided to extend along the Y direction. The pair of guide rails **63** are provided to be opposed to each other in the X direction. The pair of guide rails **63** are provided corresponding to the pair of guide grooves **45** that are provided substantially parallel to each other on the attachment surface **40***a* of the surgical instrument **40**. The pair of guide rails **63** of the second surface **60***b* are configured to receive the of guide pair of guide grooves **45** of the attachment surface **40***a* to slide the surgical instrument **40** in the Y direction so as to guide the surgical instrument **40** to a position where the drive transmission members **62***a* and **62***b* correspond to the driven members **44***b* and **44***a* provided on the attachment surface **40***a*.

The precedence guide rail **64** is provided on the second surface **60***b* of the adaptor **60**. The precedence guide rail **64** is provided to extend along the Y direction. The precedence guide rail **64** is provided between the pair of guide rails **63**. The precedence guide rail **64** is formed to extend substantially parallel to the pair of guide rails **63**. The precedence guide rail **64** is provided in the substantial center in the X direction of the second surface **60***b*. The precedence guide rail **64** is provided corresponding to the precedence guide groove **47** provided on the attachment surface **40***a*. That is, the precedence guide rail **64** guides the surgical instrument **40** before the pair of guide rails **63** guide the surgical instrument **40**.

The electrode array **65** is connected to the electrode array **48** of the surgical instrument **40** and the robot arm **21***a*.

As illustrated in FIGS. **4** and **5**, the arm engagement portion **66** is engaged with the engagement portions **213** of the robot arm **21***a*. Specifically, the arm engagement portion **66** is engaged with the engagement portions **213** that are inserted in the arm engagement holes **67** provided in the first surface **60***a*. The arm engagement portion **66** can be moved in the Y direction. The arm engagement portion **66** is biased in the Y1 direction by a bias member. The engagement of the arm engagement portion **66** with the engagement portions **213** is made by moving the arm engagement portion **66** in the Y1 direction. On the other hand, the engagement of the arm engagement portion **66** with the engagement portions **213** is released by moving the arm engagement portion **66** in the Y2 direction.

The number of the arm engagement holes **67** provided is plural. That is, the adaptor **60** is fixed to the robot arm **21***a* by engagement of plural portions. For example, the number of the plurality of arm engagement holes **67** is five. The arm engagement holes **67** are provided at equal intervals along a circumferential direction of the first surface **60***a*.

The positioning holes **68** are provided in the first surface **60***a*. The bosses **214** of the robot arm **21***a* are fitted to the positioning holes **68**. The number of the positioning holes **68** provided is plural. The positioning holes **68** are provided near an end portion in the Y1 side of the first surface **60***a*.

As illustrated in FIG. **7**, each guide rail **63** includes a rail portion **631**, a jut portion **632**, and a tab portion **633**. The rail portion **631** is formed to extend in the Y direction. The rail portion **631** is inserted into the guide groove **45** of the surgical instrument **40** and guides the movement of the surgical instrument **40** with respect to the adaptor **60**.

The jut portion **632** is formed to jut in the X direction from the rail portion **631**. Specifically, the jut portion **632** of the guide rails **63** on the X1 side is provided on the X1 side of the rail portion **631**. The jut portion **632** of the guide rail **63** on the X2 side is provided on the X2 side of the rail portion **631**.

The tab portion **633** is formed to jut in the X direction from the rail portion **631**. Specifically, the tab portion **633** of the guide rail **63** on the X1 side is provided on the X2 side of the rail portion **631**. The tab portion **633** of the guide rails **63** on the X2 side is provided on the X1 side of the rail portion **631**. That is, the jut portion **632** is provided to the rail portion **631** on the opposite side of the tab portion **633**. The jut portion **632** is provided on the outer side in the X direction of the rail portion **631**. The tab portion **633** is provided on the inner side in the X direction of the rail portion **631**.

The jut portion **632** is engaged with a restriction portion **451** (see FIG. **14**) provided in the guide groove **45** of the surgical instrument **40**. The engagement of the jut portion **632** with the restriction portion **451** enables rigid connection between the surgical instrument **40** and the adaptor **60** and prevents detachment of the surgical instrument **40** from the adaptor **60** in the Z direction.

The tab portion **633** is engaged with an engagement hole **462** (see FIG. **14**) provided in the guide groove **45** of the surgical instrument **40**. Specifically, the tab portion **633** is engaged with the engagement hole **462** provided in a side wall **463** of the movable member **46** forming the guide groove **45**. Accordingly, the engagement of the tab portion **633** with the engagement hole **462** enables positioning and fixing of the surgical instrument **40** guided by the guide rail **63** with respect to the adaptor **60**. That is, the engagement of the tab portion **633** with the engagement hole **462** enables positioning of the surgical instrument **40** in the Y direction with respect to the adaptor **60** and fixing (locking) of the surgical instrument **40** to the adaptor **60** to prevent detachment of the surgical instrument **40** in the Y direction. As illustrated in FIG. **14**, the tab portion **633** is formed to be inclined along the X direction.

As illustrated in FIG. **8**, each drive transmission member **62***a* includes a first member **621** and a second member **622**. The second member **622** is provided movably with respect to the first member **621** with a bias member **623** interposed in between. The first member **621** includes a recess portion **621***b* and an engagement portion **621***c*. The recess portion **621***b* receives the second member **622** fitted thereto. The engagement portion **621***c* is engaged with the second member **622**. The second member **622** includes a recess portion **622***a* and an engagement portion **622***b*. The recess portion **622***a* accommodates the bias member **623**. The engagement portion **622***b* is engaged with the first member **621**. The first member **621** and the second member **622** are fitted to each other in the Z direction with the bias member **623** interposed in between. The first member **621** is positioned in the second surface **60***b* side (the Z1 side) with respect to the second member **622**. The second member **622** is positioned in the first surface **60***a* side (the Z2 side). The bias member **623** biases the first member **621** toward the Z1 side with respect to the second member **622**. For example, the bias member **623** is configured as a compress coil spring. Note that the drive transmission member **62***b* has the configuration same as the drive transmission member **62***b* except for the shape of a portion where the transmission member is engaged with the driven member **44** of the surgical instrument **40**. Note that the bias member **623** is an example of a second bias member.

The first member **621** is arranged movably with respect to the base body **61** in the Z direction. This makes it possible to move the first member **621** of each of the drive transmission members **62***b* and **62***a* downward in the Z direction to prevent interference with the movement of the surgical instrument **40** when attaching the surgical instrument **40** to the adaptor **60** while guiding the surgical instrument **40** along the pair of guide rails **63**. Specifically, the pair of guide grooves **45** are configured to guide the pair of guide rails **63** in a direction (the Y direction) crossing a direction (the Z direction) in which the driven members **44***a* and **44***b* are engaged with the drive transmission members **62***b* and **62***a*. In this case, the first member **621** of each of the drive transmission member **62***a* and **62***b* can be moved so as not to obstruct the movement of the surgical instrument **40** when attaching the surgical instrument **40** to the adaptor **60** while guiding the surgical instrument **40** along the guide rails **63**.

The first member **621** is configured to rotate in accordance with the rotation of the second member **622** about the rotation axis in the Z direction. Specifically, the first member **621** and the second member **622** are configured such that the engagement portion **621***c* provided on an inner circumference of the first member **621** and the engagement portion **622***b* provided on an outer circumference of the second member **622** are engaged with each other. The engagement portion **621***c* of the first member **621** is formed to protrude inward from the recess portion **621***b*. The engagement portion **622***b* of the second member **622** is formed to be recessed inward from the outer circumference of the second member **622**. The engagement portion **621***c* of the first member **621** and the engagement portion **622***b* of the second member **622** are configured to be engaged with each other even when the first member **621** is moved with respect to the second member **622** in the Z direction. Specifically, the first member **621** is configured to be rotated with the second member **622** regardless of a location of the first member **621** with respect to the second member **622** in the Z direction. Therefore, when the second member **622** is rotated in accordance with the rotation of the rotation drive part **212** of the robot arm **21***a*, the first member **621** is rotated together. Consequently, the rotations of the rotation drive parts **212** of the robot arm **21***a* are transmitted to the driven members **44***a* and **44***b* of the surgical instrument **40** engaged with the first members **621** of the drive transmission members **62***a* and **62***b*.

(Configuration of Movable Member)

As illustrated in FIGS. **9** to **11**, each of the movable members **46** of the surgical instrument **40** includes a pressing portion **461** (button portion), the engagement hole **462**, the side wall **463**, a press-down portion **464**, a pair of guide portions **465**, and a recessed portion **466**. The movable members **46** are attached to the base body **40***b* and the holding member **49** with sandwiching a bias member **467** between the holding member **49** and each of the movable members **46**. As illustrated in FIGS. **14** and **15**, the movable members **46** are biased in directions (outward directions) in which the widths of the guide grooves **45** are decreased by the bias members **467**. The movable members **46** are moved in directions (inward directions) in which the widths of the guide grooves **45** are increased when the worker presses the pressing portion **461**. Specifically, the movable member **46** on the X1 side is biased in the X1 direction by the corresponding bias member **467**. The movable member **46** on the X1 side is moved in the X2 direction against the bias force by being pressed toward the X2 side. On the other hand, the movable member **46** on the X2 side is biased in the X2 direction by the corresponding bias member **467**. The movable member **46** on the X2 side is moved in the X1 direction against the bias force by being pressed toward the X1 side. Note that the engagement hole **462** is an example of an engagement portion. The bias member **467** is an example of a first bias member.

The pair of the movable members **46** are arranged in a direction (the X direction) substantially orthogonal to the extending direction of the shaft **42**. Thus, the pair of the movable members **46** are engaged with the adaptor **60** to fix the surgical instrument **40** in a well-balanced manner. Therefore, the surgical instrument **40** can be more stably fixed to the adaptor **60**.

The pressing portion **461** is provided to be pressed (operated) by the worker. As illustrated in FIG. **5**, the pressing portion **461** is provided on the outer side in the X direction so as to be exposed from the housing **43**. The pressing portion **461** is formed with a plurality of grooves extending along the Y direction. This makes it possible to recognize the pressing portion **461** only by touching the position of the pressing portion **461** and also to suppress slipping of the hand of the operator.

The engagement hole **462** is engaged with the tab portion **633** provided on the guide rail **63** of the adaptor **60**. As illustrated in FIG. **11**, the engagement hole **462** is formed in the side wall **463**. As illustrated in FIGS. **14** and **15**, the engagement hole **462** is formed to penetrate through the side wall **463** in the X direction. This allows the positioning and fixing to the adaptor **60** of the surgical instrument **40** that is guided by the guide rails **63**.

As illustrated in FIG. **15**, the movable members **46** are configured to be disengaged from the adaptor **60** by moving the movable members **46** with respect to the base body **40***b* and the holding member **49**. Accordingly, by engaging the movable members **46** to the adaptor **60**, the surgical instrument **40** can be easily attached to the adaptor **60** and can be stably fixed to the adaptor **60**. Further, by moving the movable members **46** with respect to the base body **40***b* and the holding member **49**, the engagement between the movable members **46** and the adaptor **60** can be released. Thus, the surgical instrument **40** can be easily detached from the adaptor **60**. Therefore, the surgical instrument **40**, which is to be detachably connected to the robot arm **21***a* of the robotic surgical system **100** through the adaptor **60**, can be easily attached to and detached from the adaptor **60** and can be stably fixed to the adaptor **60**.

The side wall **463** constitutes an inner wall in the X direction of the guide groove **45**. Specifically, as illustrated in FIGS. **14** and **15**, the side wall **463** is arranged to face the restriction portion **451** provided on the base body **40***b*. The guide groove **45** defined by the side wall **463** and the restriction portion **451** sandwiches the rail portion **631** of the guide rail **63** to guide the guide rail **63**.

The restriction portion **451** is provided on the base body **40***b* side in the guide groove **45**. The restriction portion **451** is formed to extend in the Y direction. The restriction portion **451** is engaged with the jut portion **632** provided on the guide rail **63** and projected in the direction (the X direction) parallel to the attachment surface **40***a*, and restricts the movement of the attachment surface **40***a* with respect to the adaptor **60** in the direction (the Z direction) of the rotation axis of the driven members **44***a* and **44***b*.

As illustrated in FIGS. **14** and **15**, when the press-down portion **464** is moved to release the engagement of the engagement hole **462** with the adaptor **60**, the press-down portion **464** disengages the drive transmission member **62***a* (**62***b*) from the driven member **44***b* (**44***a*) by moving the first member **621** of the drive transmission member **62***a* (**62***b*) in the direction away from the driven member **44***b* (**44***a*). With this configuration, the operation of releasing the engagement of the movable members **46** with the adaptor **60** and the operation of releasing the engagement of the driven members **44***b* (**44***a*) with the drive transmission members **62** can be performed at the same time. Consequently, it is possible to detach the surgical instrument **40** from the adaptor **60** easily.

Specifically, the press-down portion **464** is configured to disengage the drive transmission members **62***a* (**62***b*) from the driven members **44***b* (**44***a*) by being moved in the direction (the X direction) crossing the direction in which the driven members **44***b* (**44***a*) are engaged with the drive transmission members **62***a* (**62***b*), along with the movement of the movable member **46**.

Specifically, the press-down portion **464** is configured, along with the movement of the movable member **46**, to run onto tapered portion **621***a* of the first member **621** and to move the first member **621** in the direction (the Z2 direction) away from the driven member **44***b* (**44***a*).

The press-down portion **464** is connected to an inner side in the X direction of the Z2 side portion of the side wall **463**. The press-down portion **464** is formed in a plate shape extending in the XY plane. The press-down portion **464** includes recesses in portions corresponding to the driven member **44***b* (**44***a*).

The pair of guide portions **465** are configured to guide the movement of the movable members **46** in the X direction. The pair of guide portions **465** are arranged side by side in the Y direction. The pair of guide portions **465** are formed to extend in the X direction. Specifically, each of the pair of guide portions **465** extends inwardly from the inner surface of the pressing portion **461**. As illustrated in FIG. **13**, the movement of the guide portion **465** is restricted in an upper direction by the holding member **49** and in a lower direction by the base body **40***b*.

The recessed portion **466** is configured such that the bias member **467** is fit into the recessed portion **466**. The recessed portion **466** is provided to be recessed outwardly from the inner surface of the pressing portion **461**. The recessed portion **466** is provided in the vicinity of the center in the Z direction of the pressing portion **461**. The recessed portion **466** is provided in the vicinity of the center in the Y direction of the pressing portion **461**. With this, the biasing force of the bias member **467** acts on the center of the pressing portion **461**.

The bias member **467** biases the movable member **46** toward an outer direction of the base body **40***b*. The inner end of the bias member **467** is retained by the holding member **49**. Accordingly, the movement of the bias member **467** toward the inner side along the X direction is restricted. As a result, the bias member **467** can be held by the holding member **49** which holds the driven member **44***b* (**44***a*). Thus, it is not necessary to additionally provide a dedicated member for holding the bias member **467**. Therefore, it is possible to suppress an increase in the number of components. The outer end of the bias member **467** is fit in the recessed portion **466** provided on the inner surface of the pressing portion **461**. For example, the bias member **467** is configured as a compression coil spring.

As illustrated in FIG. **9**, the base body **40***b* is provided with an opening **40***c* which communicates with the engagement hole **462** from the outside of the base body **40***b*. Therefore, even when it is difficult to operate the pressing portion **461**, an operation to move the engagement hole **462** can be done through the opening **40***c* so as to release the engagement of the engagement hole **462** with the adaptor **60**.

(Configuration of Holding Member)

As illustrated in FIG. **12**, the holding member **49** of the surgical instrument **40** includes an upper surface **49***a* and a pair of side surfaces connected to the upper surface **49***a*. The upper surface **49***a* of the holding member **49** is formed with support portions **491** that rotatably support the driven members **44***a* and **44***b*, respectively. Each of the side surfaces **49***b* of the holding member **49** is formed with a projection **492**, restriction portions **493**, and claws **494**. The holding member **49** is made of resin.

Each of the driven member **44***a* and **44***b* includes one end (the Z2 side end) to be rotatably supported by the base body **40***b* and the other end (the Z1 side end) to be rotatably supported by the holding member **49**. The holding member **49** is configured to rotatably support the other end (the Z1 side end) of each of the plural driven members **44***a* and **44***b*. Specifically, as illustrated in FIG. **13**, the holding member **49** is engaged with the base body **40***b* and holds the end of each of the driven members **44***a* and **44***b* with a retaining ring **445** such an e-ring or the like, so that the holding member **49** is fixed to the base body **40***b*. With this, the holding member **49** can be stably fixed to the base body **40***b*. Thus, the driven members **44***a* and **44***b* can be stably held by the holding member **49**.

More specifically, a rotational shaft **444** of each of the driven members **44***a* (**44***b*) is inserted into a through hole **40***d* (see FIG. **14**) of the base body **40***b* from the Z2 side with a bearing therebetween. Then, a member around which the wire **421** is to be wound is attached to the rotational shaft **444**, and the wire **421** is attached to the member attached to the rotational shaft **444**. After that, the holding member **49** is engaged with the base body **40***b*. Specifically, the plural claws **494** of the holding member **49** are engaged with the base body **40***b* by snap fit. At this time, the Z1 side end of each of the driven members **44***a* (**44***b*) is inserted into the support portion **491** of the holding member **49** with a bearing therebetween. Then, the retaining ring **445** serving as a fastener or an attachment is fit to a groove **444***a* provided on an outer circumference of the shaft **444** of each of the driven members **44***a* (**44***b*), so that the end of each of driven members **44***a* and **44***b* is held by the holding member **49**. Therefore, the holding member **49** is fixed to the base body **40***b* and the Z1 side end of each of the driven members **44***a* (**44***b*) is rotatably supported by the holding member **49**.

The support portions **491** are provided at positions corresponding to the positions of the driven members **44***a* and **44***b*. Each of the support portions **491** is formed with a through hole penetrating therethrough in the Z direction. Each of the support portions **491** is configured to rotatably hold the end (Z1 side end) of each of the did plural driven members **44***a* and **44***b* whose other end (the Z2 side end) is supported by the base body **40***b*.

The projection **492** of the holding member **49** is projected outwardly toward the movable member **46** side. The bias member **467** is attached to the projection **492** such that the projection **492** is inserted into the bias member **467**. Accordingly, by the projection **492** provided on the holding member **49**, the bias members **467** can be easily held.

The restriction portions **493** of the holding member **49** restrict the movements of the guide portions **465** of the movable member **46** in the Z1 direction.

The plural claws **494** of the holding member **49** are engaged with the base body **40***b* by snap fit.

(Attachment of Surgical Instrument to Robot Arm)

With reference to FIGS. **16** to **18**, attachment of the surgical instrument **40** to the robot arm **21***a* according to an embodiment is described.

As illustrated in FIGS. **16** and **17**, the adaptor **60** is attached to the robot arm **21***a* with the robot arm **21***a* being covered by the drape **70**. The adaptor **60** is moved in the Z direction with respect to the robot arm **21***a*, so as to be attached to the robot arm **21***a*. As illustrated in FIG. **18**, the surgical instrument **40** is attached to the adaptor **60** attached to the robot arm **21***a*. The surgical instrument **40** is moved in the Y1 direction along the guide rails **63** of the adaptor **60**, so as to be attached to the adaptor **60**. In this way, the surgical instrument **40** is attached to the robot arm **21***a* through the adaptor **60**.

When detaching the surgical instrument **40** from the robot arm **21***a*, a user slides the surgical instrument **40** in the Y2 direction while pressing the pressing portions **461** of the movable members **46** of the surgical instrument **40**, to detach the surgical instrument **40** from the adaptor **60**.

(Modifications)

It should be understood that one or more embodiments described above are illustrated by way of example in every respect and not limit the disclosure. The scope of the disclosure is defined not by one or more embodiments described above, but by the scope of claims, and includes all modifications (variations) within equivalent meaning and scope to those of the claims.

For example, in one or more embodiments described above, the surgical instrument is attached or detached by being slid in the extending direction of the shaft along the second surface of the adaptor. However, the disclosure is not limited thereto. In this disclosure, a surgical instrument may be attached or detached by being slid in a direction crossing an extending direction of a shaft along a second surface of an adaptor.

Further, in one or more embodiments described above, the guide groove is defined by the movable member and the based body. However, the disclosure is not limited thereto. In this disclosure, a guide groove to slidably receive a guide rail provided at an adaptor may be formed by at least a movable member.

Further, in one or more embodiments described above, the movable member is movable in the direction crossing the extending direction of the shaft. However, the disclosure is not limited thereto. In this disclosure, a movable member may be movable in a direction along an extending direction of a shaft. Further, a movable member may be movable in a direction along a rotational axis of a driven member.

Further, in one or more embodiments described above, the attachment surface of the surgical instrument is formed in a substantially circular shape in the plan view. However, the disclosure is not limited thereto. In this disclosure, an attachment surface of a surgical instrument may not be formed in a substantially circular shape in a plan view. For example, an attachment surface of a surgical instrument may be formed in a rectangular shape in a plan view.

Further, in one or more embodiments described above, the four driven members are provided on the base body of the surgical instrument. However, the disclosure is not limited thereto. In this disclosure, the number of a plurality of driven members provided on a base body of a surgical instrument may be other than four.

In one or more embodiments described above, the adaptor and drape are separately provided. However, the disclosure is not limited thereto. In this disclosure, an adaptor and a drape may be integrally provided.

The invention claimed is:

1. A surgical instrument to be detachably connected to a robot arm of a robotic surgical system through an adaptor, comprising:

a base body including an attachment surface to be attached to the adaptor;

an elongated shaft including one end connected to the base body and the other end;

a treatment tool provided on a side of the other end of the elongated shaft;

elongate elements for operating the treatment tool;

driven members rotatably provided on the base body and connected with end portions of the elongate elements;

a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and

a movable member provided with being movable with respect to the holding member and the base body and engaged with the adaptor, wherein

the movable member is configured to be disengaged from the adaptor, when the movable member is moved with respect to the holding member and the base body.

2. The surgical instrument according to claim **1**, wherein

the movable member defines at least partially a guide groove that slidably receives a guide rail provided to the adaptor, and

the movable member is configured to change a groove width of the guide groove when the movable member is moved.

3. The surgical instrument according to claim **1**, further comprising

a first bias member biasing the movable member toward an outer periphery of the base body, wherein

the first bias member is held by the holding member.

4. The surgical instrument according to claim **3**, wherein

the holding member includes a projection projected toward the movable member,

the first bias member comprises a compression coil spring, and

the compression coil spring is inserted to the projection.

5. The surgical instrument according to claim **1**, wherein

the holding member is engaged with the base body and holds the other end of each of the driven members with an attachment.

6. The surgical instrument according to claim **5**, wherein

the attachment comprises a retaining ring.

7. The surgical instrument according to claim **6**, wherein

each of the driven members includes a shaft including an outer circumference formed with a groove, and

the holding member holds the other end of each of the driven members by the retaining ring being fit in the groove of the shaft of each of the driven members.

8. The surgical instrument according to claim **1**, wherein

the movable member includes a pressing portion to be pressed and an engagement portion to be engaged with the adaptor, and

the base body includes an opening through which the engagement portion is accessible from the outside of the base body.

9. The surgical instrument according to claim **8**, wherein the engagement portion of the movable member includes an engagement hole to be engaged with a claw provided to the adaptor.

10. The surgical instrument according to claim **1**, wherein

the adaptor includes drive transmission members each of which includes a first member and a second member provided movably with respect to the first member with a second bias member interposed therebetween, the drive transmission members being provided to be engaged with the driven members, and

the movable member includes a press-down portion configured to, when the movable member is moved to disengage the movable member from the adaptor, move the first members of the drive transmission members in a direction away from the driven members so as to disengage the drive transmission members from the driven members.

11. The surgical instrument according to claim **1**, wherein the movable member comprises a pair of movable members arranged in a direction substantially orthogonal to an extending direction of the elongated shaft.

12. Assembly comprising:

an adaptor that is to be attached to a robot arm of a robotic surgical system; and

a surgical instrument detachably connected to the adaptor, wherein

the surgical instrument includes:

a base body including an attachment surface to be attached to the adaptor;

an elongated shaft including one end connected to the base body and the other end;

a treatment tool provided on a side of the other end of the elongated shaft;

elongate elements for operating the treatment tool;
driven members rotatably provided on the base body and connected with end portions of the elongate elements;
a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and
a movable member provided with being movable with respect to the holding member and the base body and engaged with the adaptor, wherein
the movable member is configured to be disengaged from the adaptor, when the movable member is moved with respect to the holding member and the base body.

13. The assembly according to claim **12**, wherein
the adaptor includes a pair of guide rails,
the attachment surface of the surgical instrument includes a pair of guide grooves to slidably receive the pair of guide rails, and
groove widths of the guide grooves are changed when the movable member is moved.

14. The assembly according to claim **12**, wherein
the surgical instrument includes a first bias member biasing the movable member toward an outer periphery of the base body, and
the first bias member is held by the holding member.

15. The assembly according to claim **14**, wherein
the holding member includes a projection projected toward the movable member,
the first bias member comprises a compression coil spring, and
the compression coil spring is inserted to the projection of the holding member.

16. The assembly according to claim **12**, wherein
the holding member is engaged with the base body and holds the other end of each of the driven members with an attachment.

17. The assembly according to claim **13**, wherein
each of the pair of guide rails includes a rail portion extending in a first direction and a claw projected from the rail portion in a second direction substantially orthogonal to the first direction,
the movable member includes a pressing portion to be pressed and an engagement portion to be engaged with the adaptor, and
the engagement portion includes an engagement hole to be engaged with the claw.

18. The assembly according to claim **12**, wherein
the adaptor includes drive transmission members each of which includes a first member and a second member provided movably with respect to the first member with a second bias member interposed therebetween, the drive transmission members being provided to be engaged with the driven members of the surgical instrument, and
the movable member includes a press-down portion configured to, when the movable member is moved to disengage the movable member from the adaptor, move the first members of the drive transmission members in a direction away from the driven members so as to disengage the drive transmission members from the driven members.

19. A robotic surgical system, comprising:
a robot arm;
an adaptor attached to the robot arm; and
a surgical instrument detachably connected to the adaptor, wherein
the surgical instrument includes:
a base body including an attachment surface to be attached to the adaptor;
an elongated shaft including one end connected to the base body and the other end;
a treatment tool provided on a side of the other end of the elongated shaft;
elongate elements for operating the treatment tool;
driven members rotatably provided on the base body and connected with end portions of the elongate elements;
a holding member rotatably holding the driven members such that one end of each of the driven members is rotatably held by the base body and the other end of each of the driven members is rotatably held by the holding member; and
a movable member provided with being movable with respect to the holding member and the base body and engaged with the adaptor, and
the movable member is configured to be disengaged from the adaptor, when the movable member is moved with respect to the holding member and the base body.

20. The robotic surgical system according to claim **19**, wherein
the adaptor is a drape adaptor that sandwiches a drape between the adaptor and the robot arm.

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